Forty Years of Change in Glacier Ice Coverage at Katmai National Park and Preserve Alaska

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March, 2007

Homer, Alaska

Outline

- Objectives
- Parks involved
- Methodology
- Issues and Limitations
- Key findings
- Examples of glacier change
- Summary and Conclusions
- Future plans

Objective and Parks Involved

- The overall objective is to measure glacier changes in Kenai Fjords, Katmai, and Lake Clark National Parks & Preserves during the Landsat era (early 1970s-present)
- Extent and change in extent of glaciers will be measured in each decade if possible, and provided as GIS shape files so that future measurements of the glacier extents can be compared quantitatively with Landsat-derived results

General Methodology

Glacier Extent Mapping

1. Acquire late-season, cloud-free Landsat Imagery

2. Classify the imagery for snow and ice using image processing software

3. Convert the classified image (raster data) to vector data and export as a GIS shape file

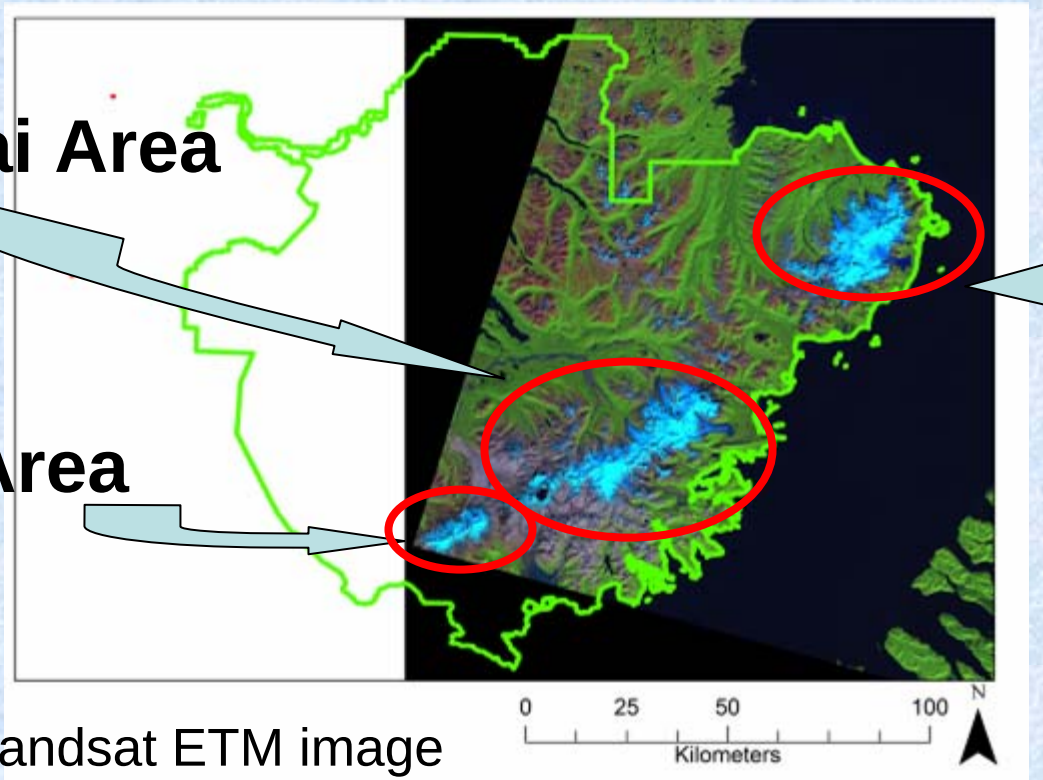
4. Edit the shape file in ArcGIS correcting for areas of miss-classification

General Methodology

Katmai National Park and Preserve

Glaciers are found in three regions of the park.

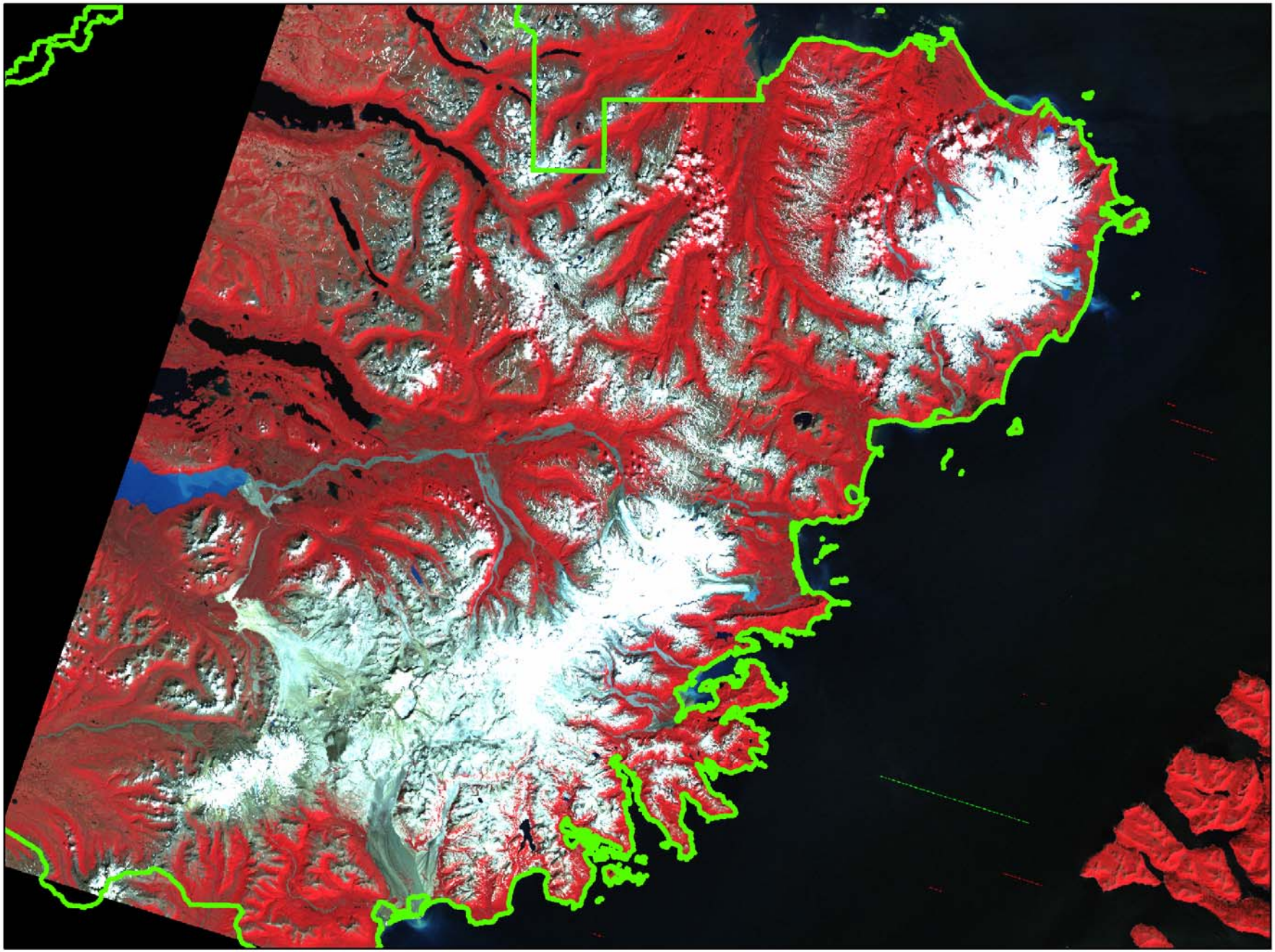
- Cape Douglas, Fourpeaked Mtn. area
- Mt.Katmai, Snowy Mtn and Kukak Volcano area
- Mt. Martin and Mt. Mageik area



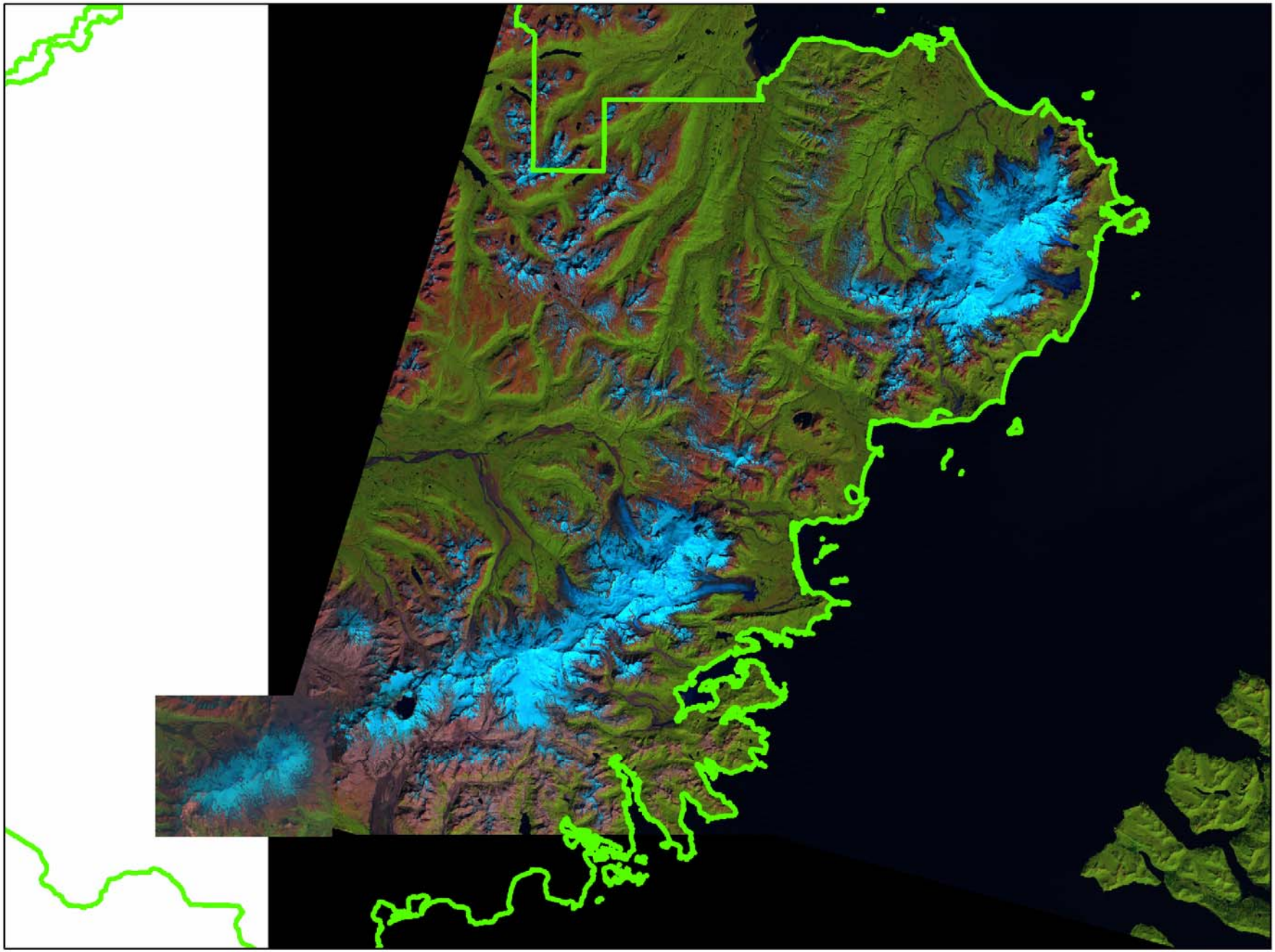
August 16, 2000 Landsat ETM image

Katmai Glaciers have been studied with the following Landsat data

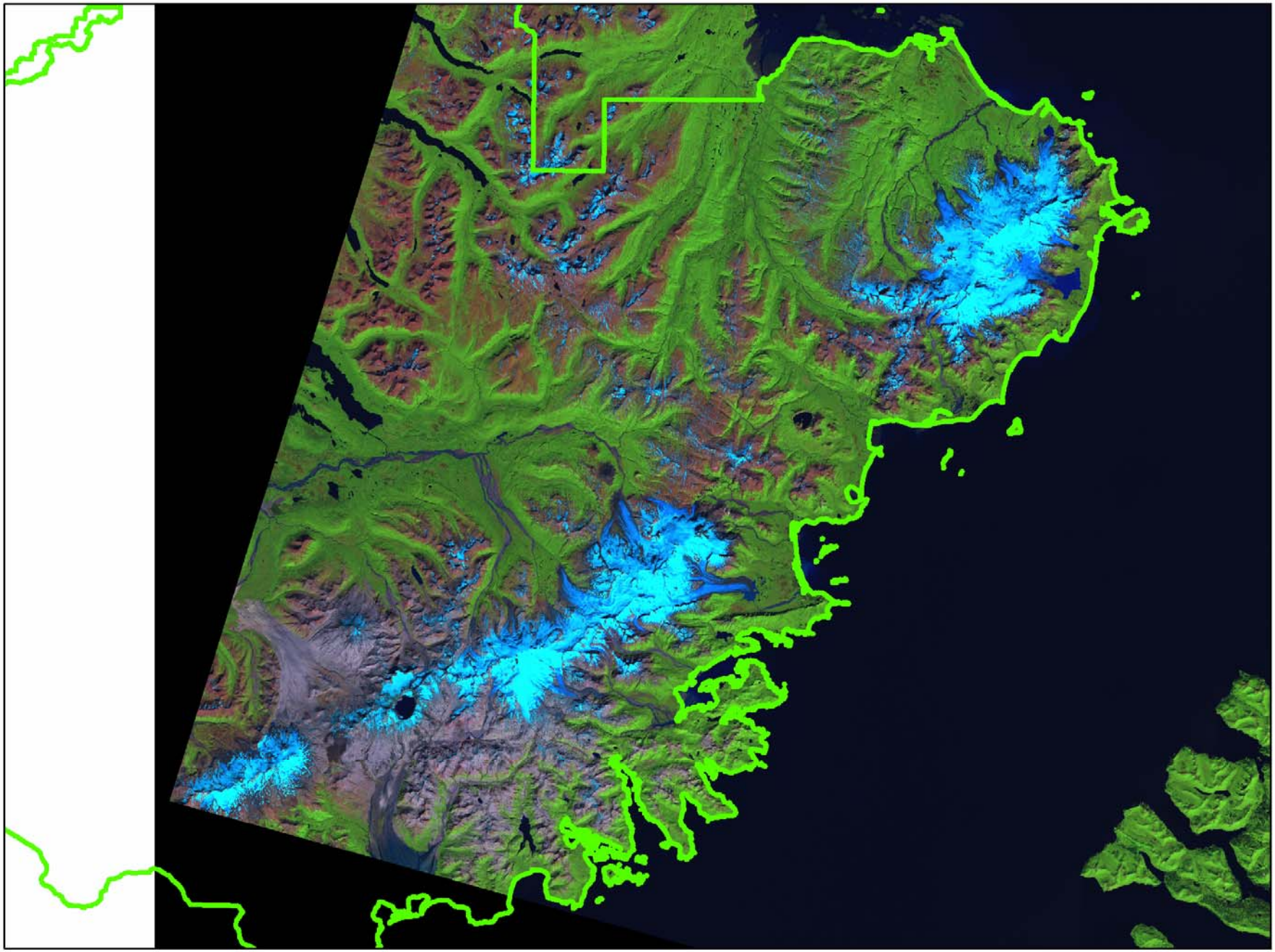
Landsat scenes used in this work	
27 July 1974	MSS (80-m resolution)
24 July 1986	TM (30 m)
21 August 1987	TM (30 m)
16 August 2000	ETM+ (30 & 15 m)



27 July 1974 MSS (80-m resolution)

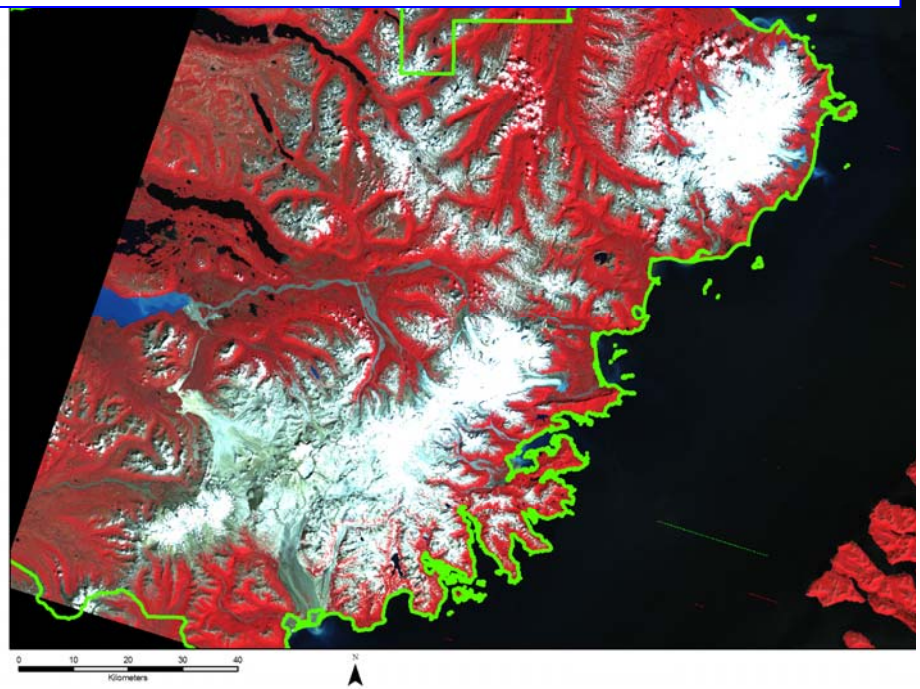


21 August 1987, 24 July 1986 TM (30 m)

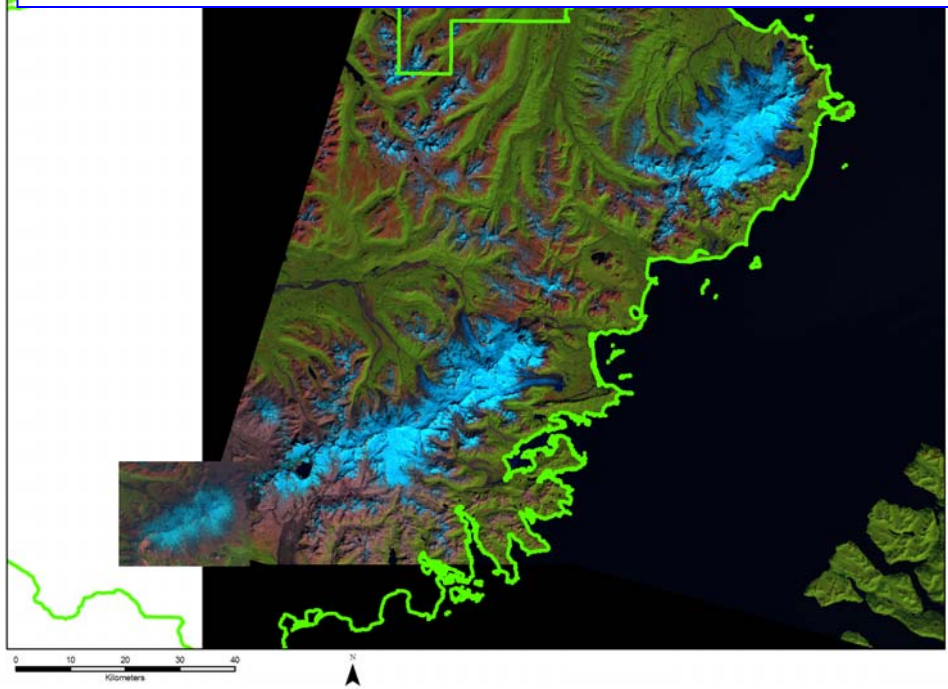


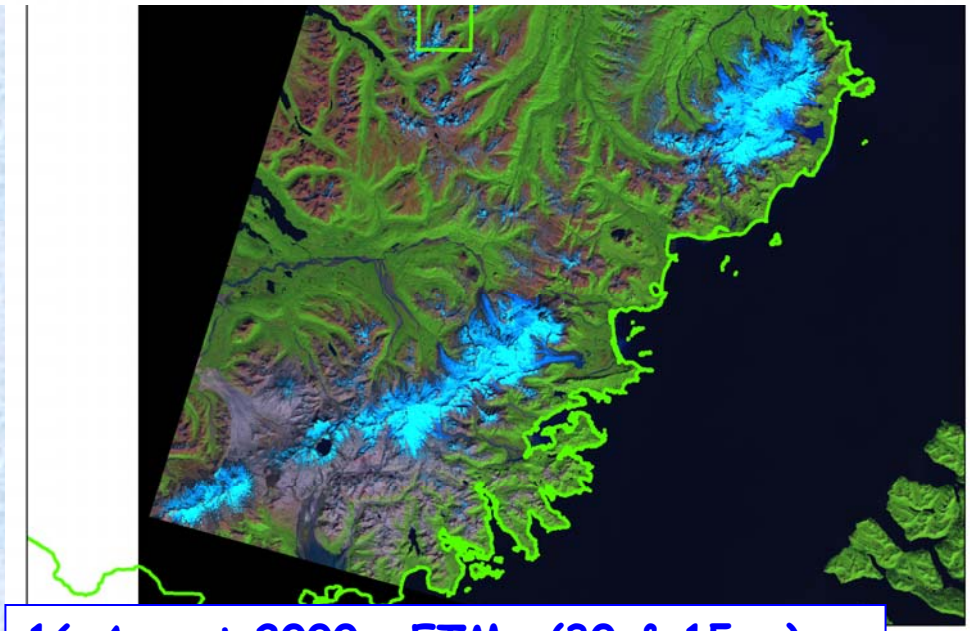
16 August 2000 ETM+ (30 & 15 m)

27 July 1974 MSS (80-m resolution)



21 August 1987, 24 July 1986 TM (30 m)



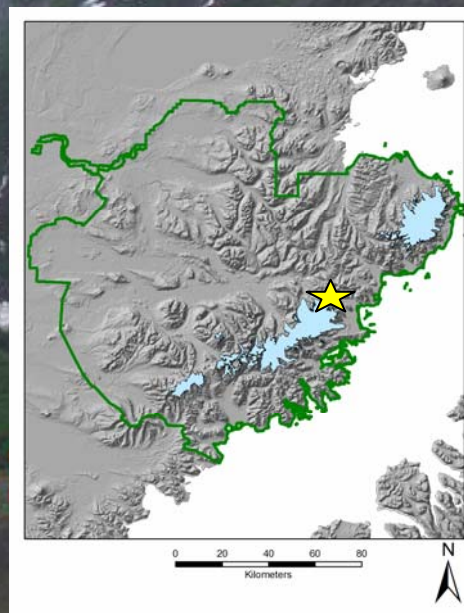


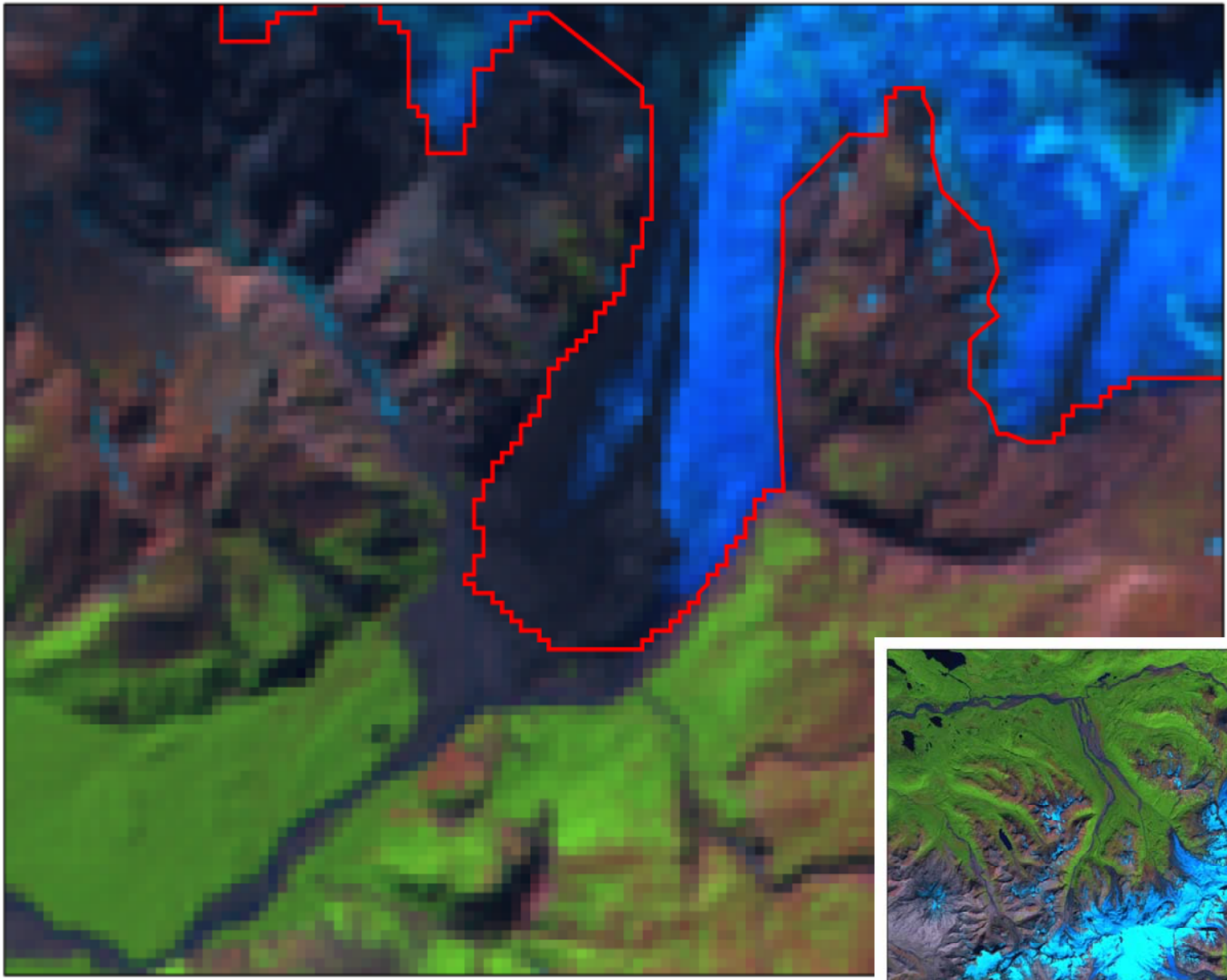
16 August 2000 ETM+ (30 & 15 m)

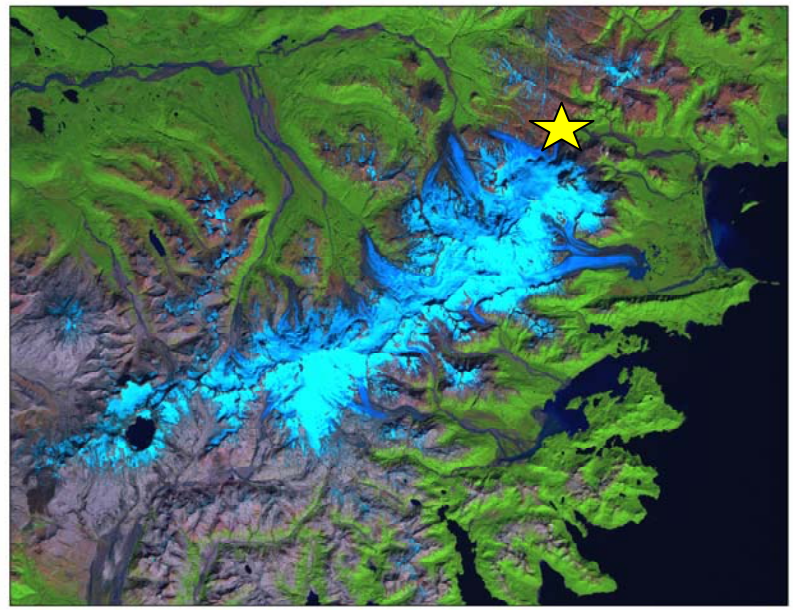
Issues and Limitations

- Debris cover can mask the glacier terminus especially in the case of retreating glaciers
- Fresh snow cover
- Late-season snowpack
- Shadows
- Clouds
- Spatial resolution differences between images

Unnamed glacier – debris covered terminus

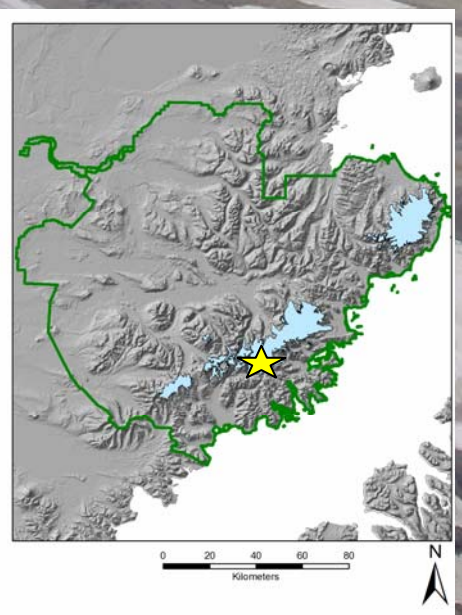




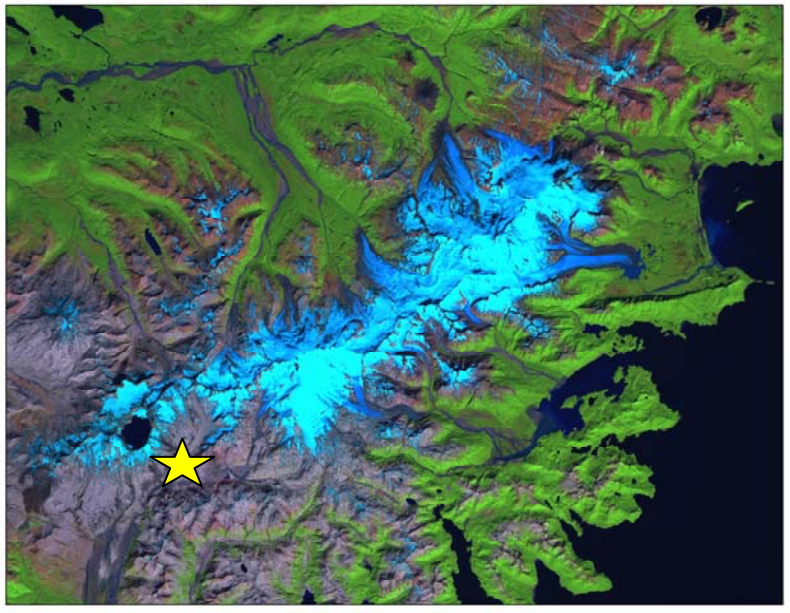


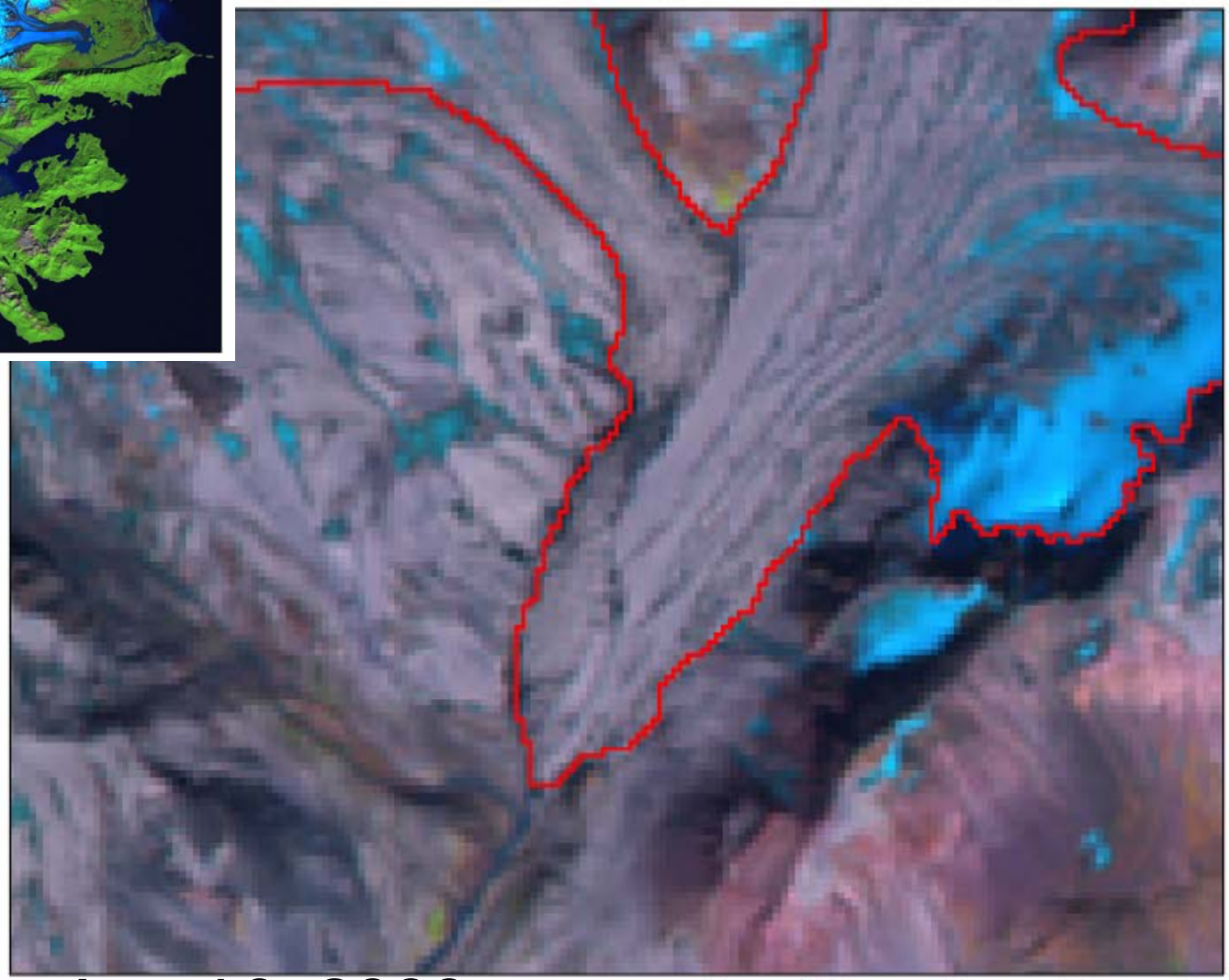
Landsat image – Aug 16, 2000

Unnamed glacier – volcanic ash covered terminus



21 11:33 AM





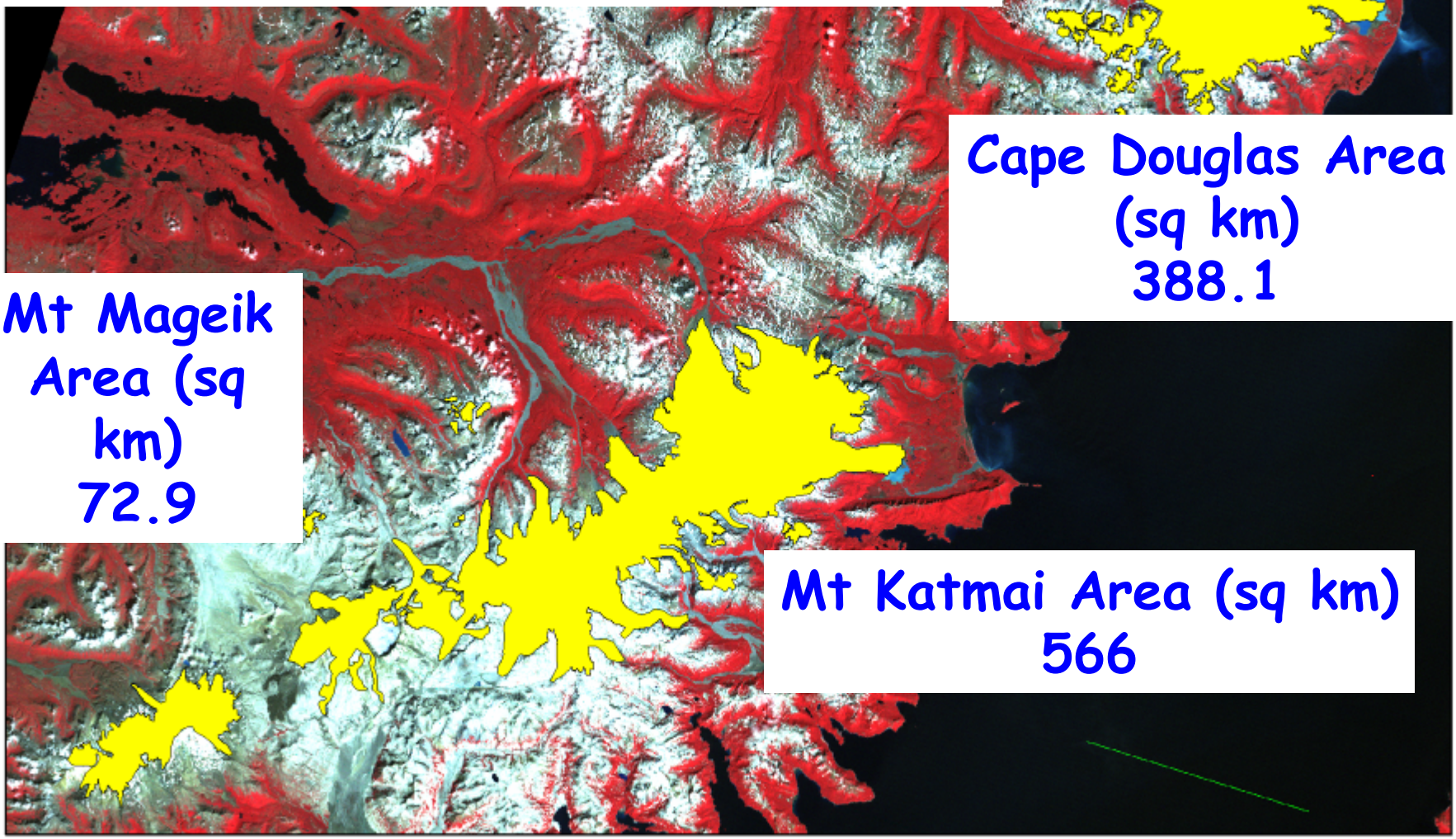
Landsat image – Aug 16, 2000

0 0.5 1 1.5 2

Kilometers

1974 Glacier Extent

Katmai National Park (sq km)
1027



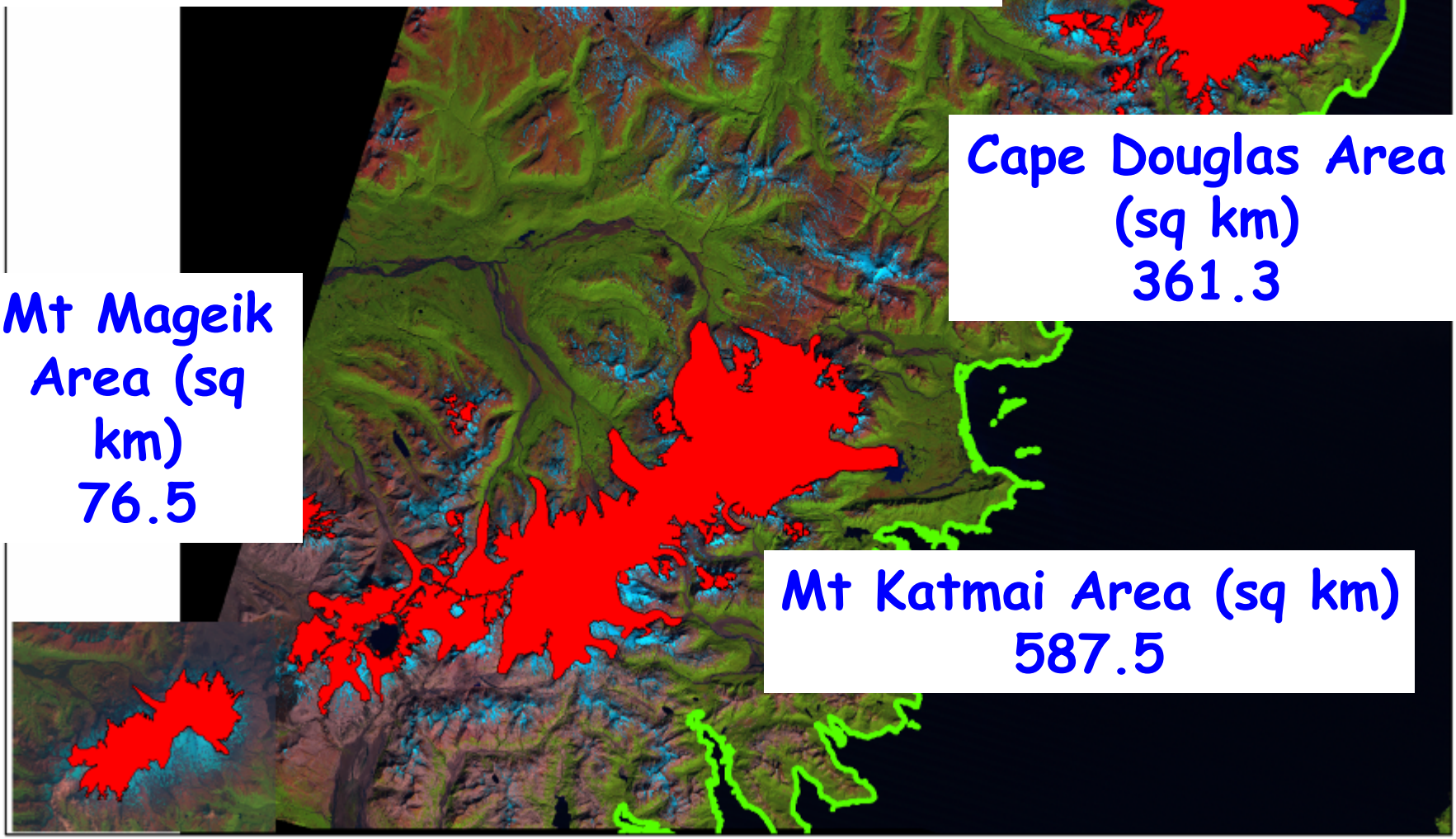
Cape Douglas Area (sq km)
388.1

Mt Mageik Area (sq km)
72.9

Mt Katmai Area (sq km)
566

1987 Glacier Extent

Katmai National Park (sq km)
1025



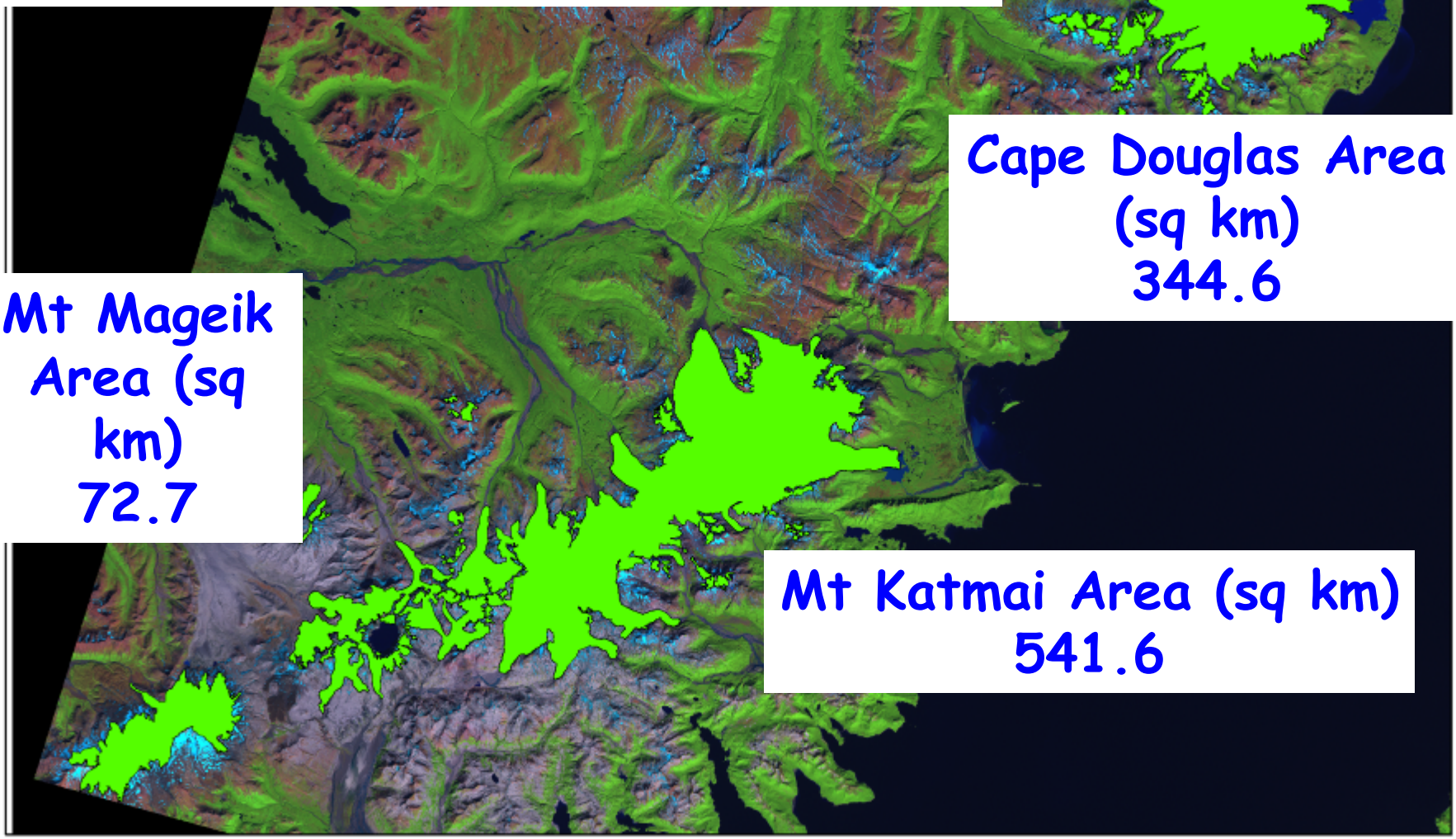
Cape Douglas Area (sq km)
361.3

Mt Mageik Area (sq km)
76.5

Mt Katmai Area (sq km)
587.5

2000 Glacier Extent

Katmai National Park (sq km)
959



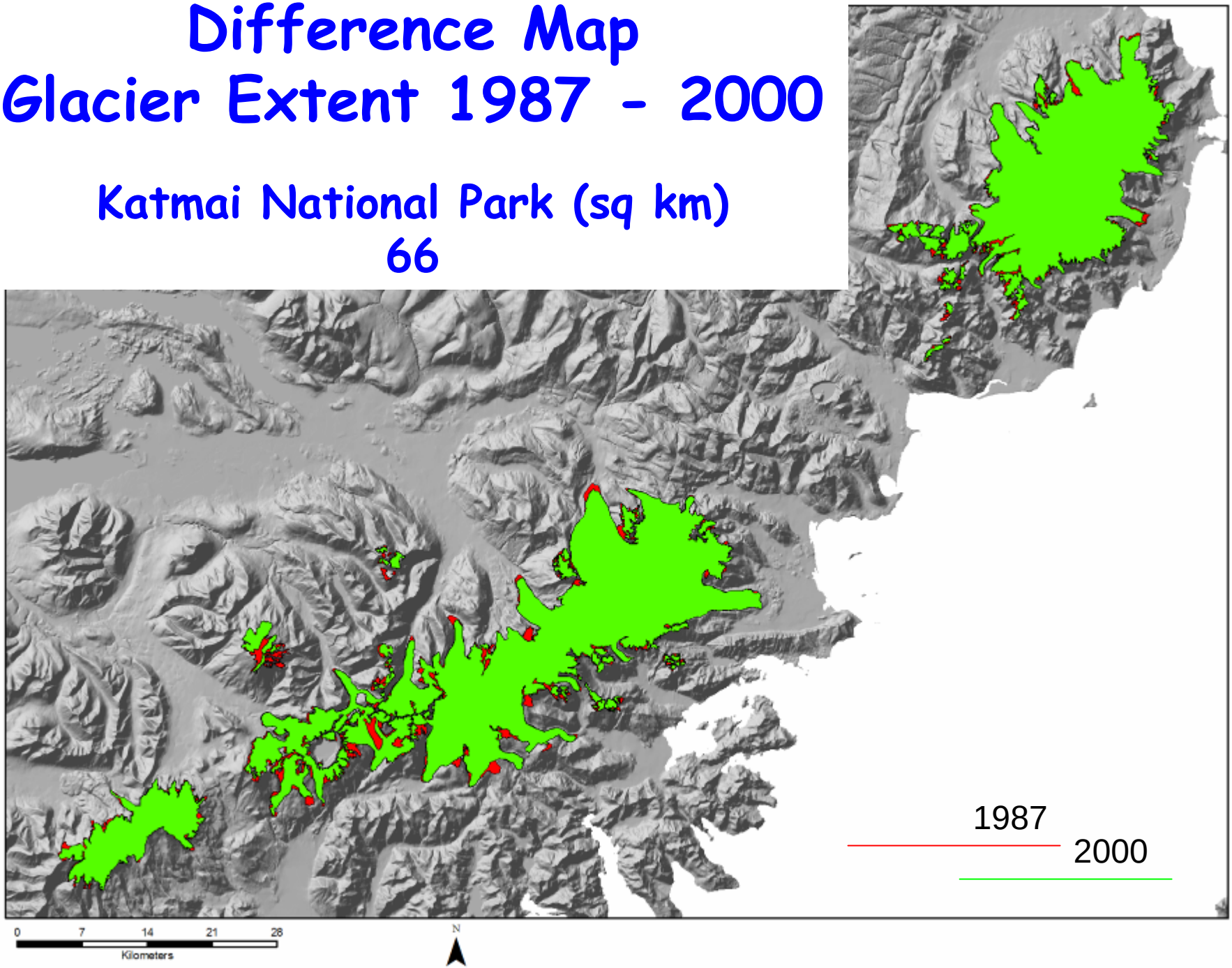
Cape Douglas Area (sq km)
344.6

Mt Mageik Area (sq km)
72.7

Mt Katmai Area (sq km)
541.6

Difference Map
Glacier Extent 1987 - 2000

Katmai National Park (sq km)
66



Key Findings

Change in Glacial Extent

as Measured from Landsat Imagery

1974 Glacial Extent
1027*

1987 Glacial Extent
1025*

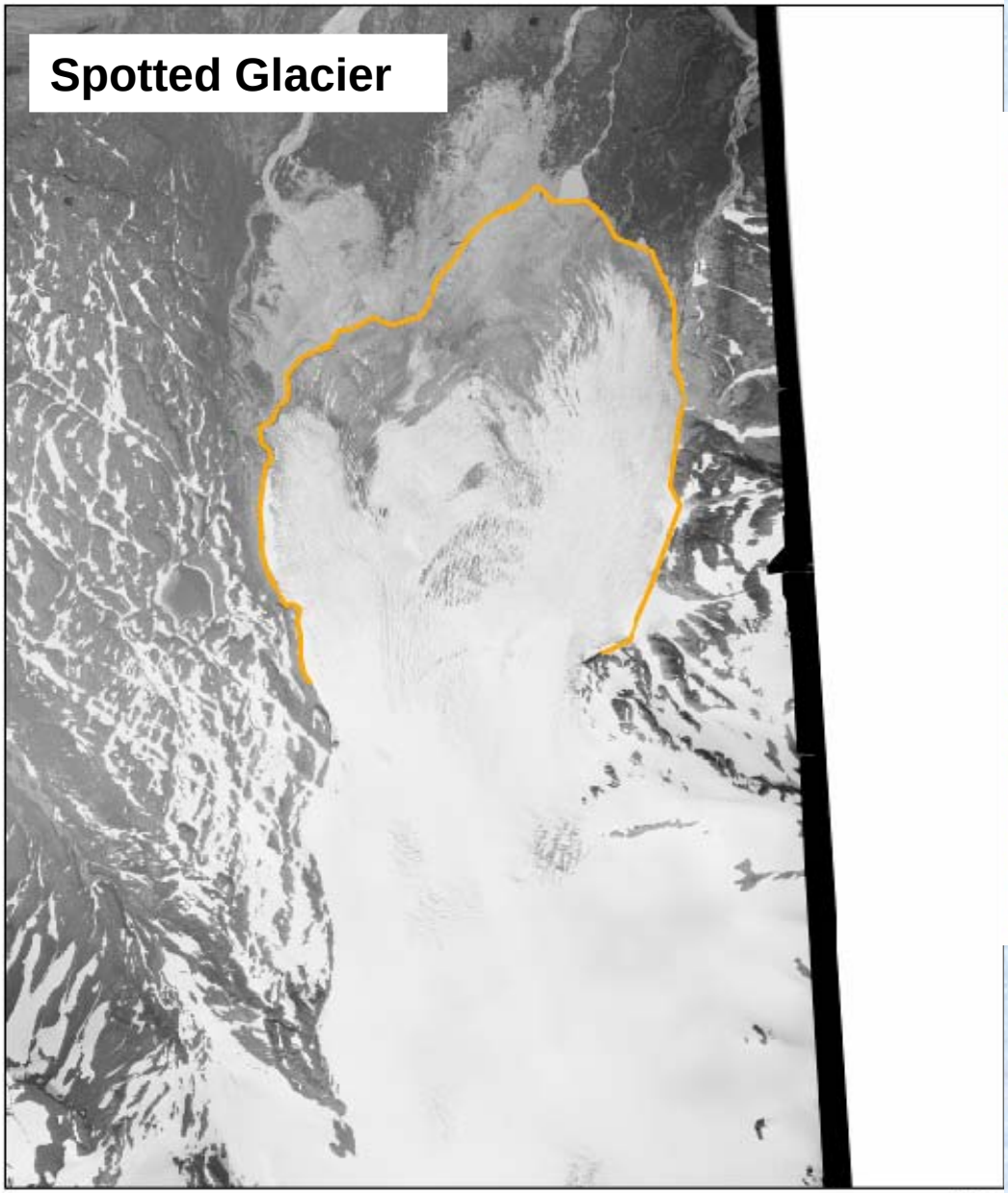
1974 to 1987 Change in Glacial Extent
-1.9%

2000 Glacial Extent
959*

1987 to 2000 Change in Glacial Extent
-6.4%

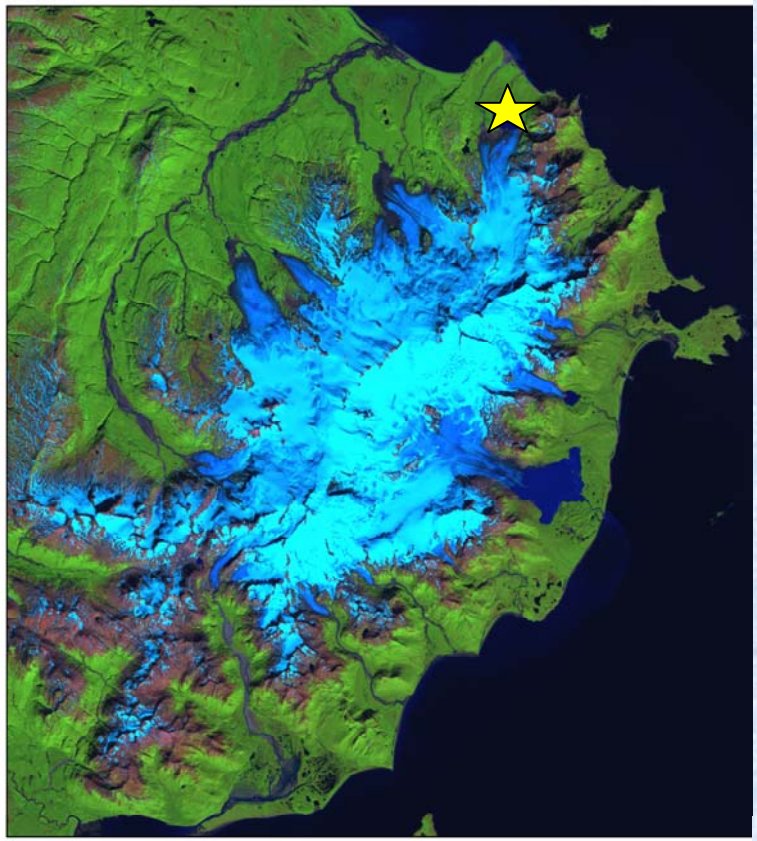
***Measurement in square kilometers**


Hook Glacier
Lets look at a few glacier termini
20 1:16 PM

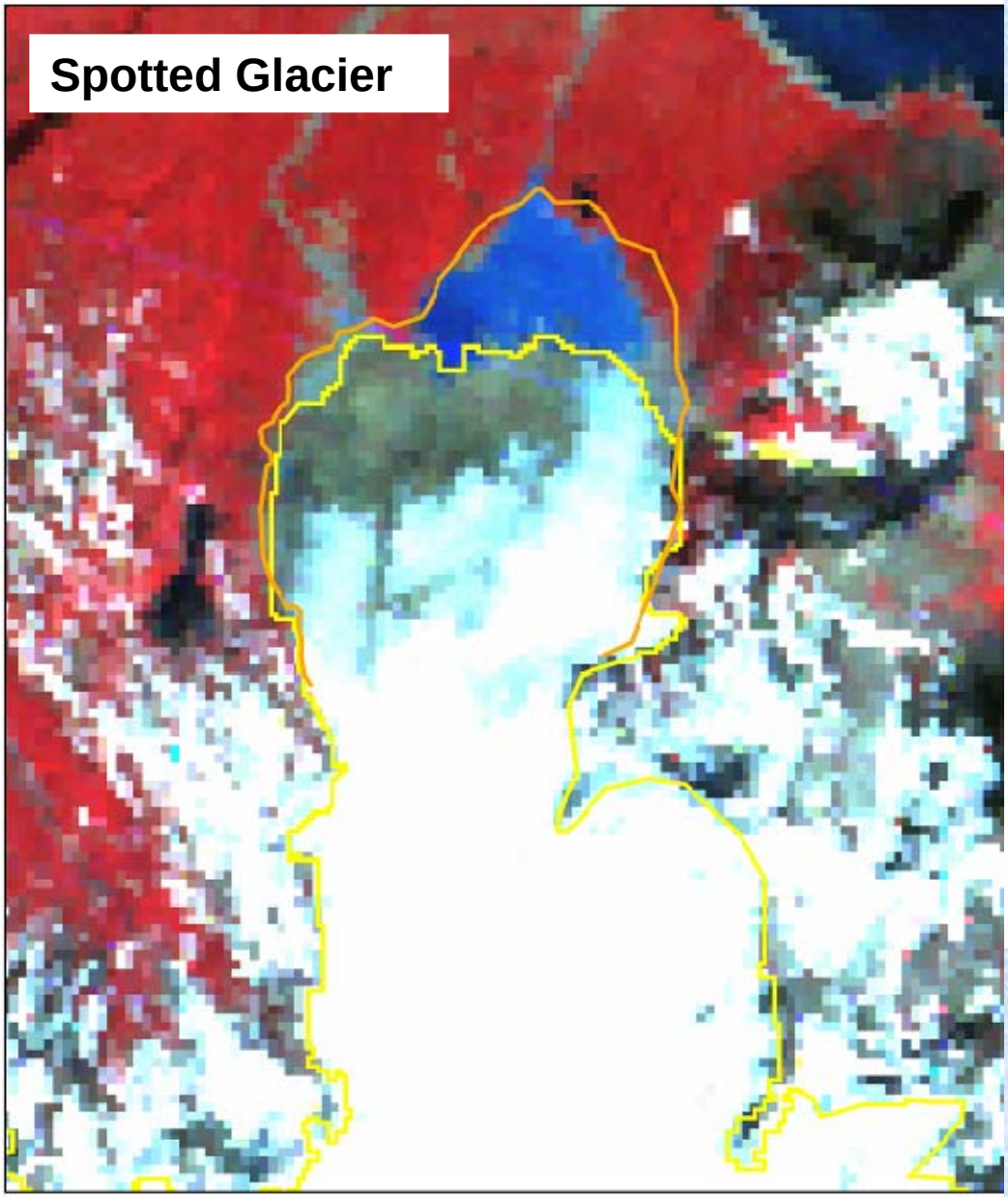


USGS Aerial Photo
July, 1951

Cape Douglas Area

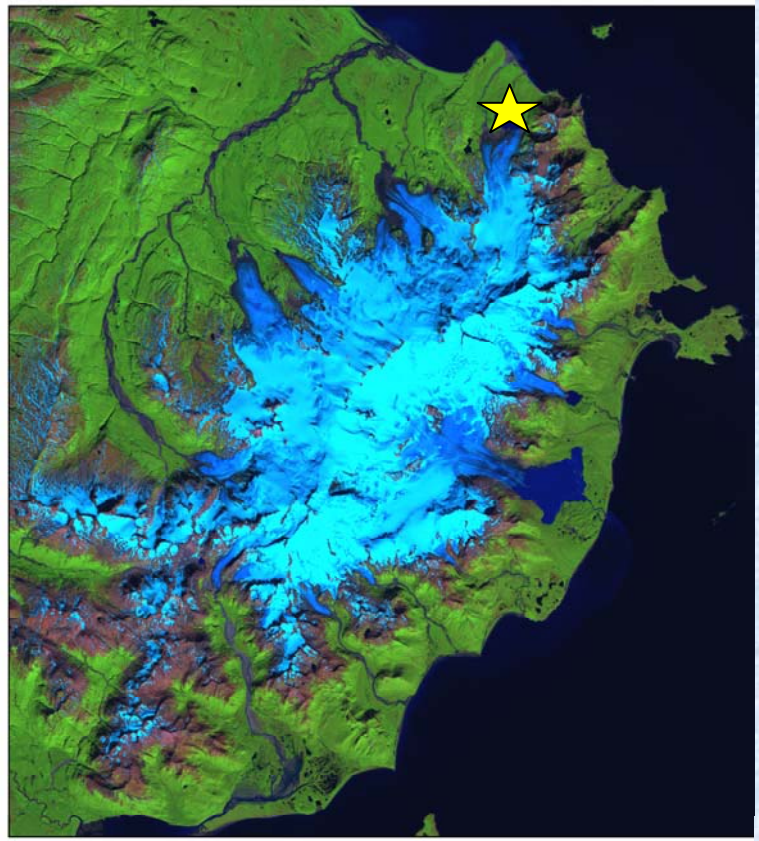


1951



Landsat July 27, 1974

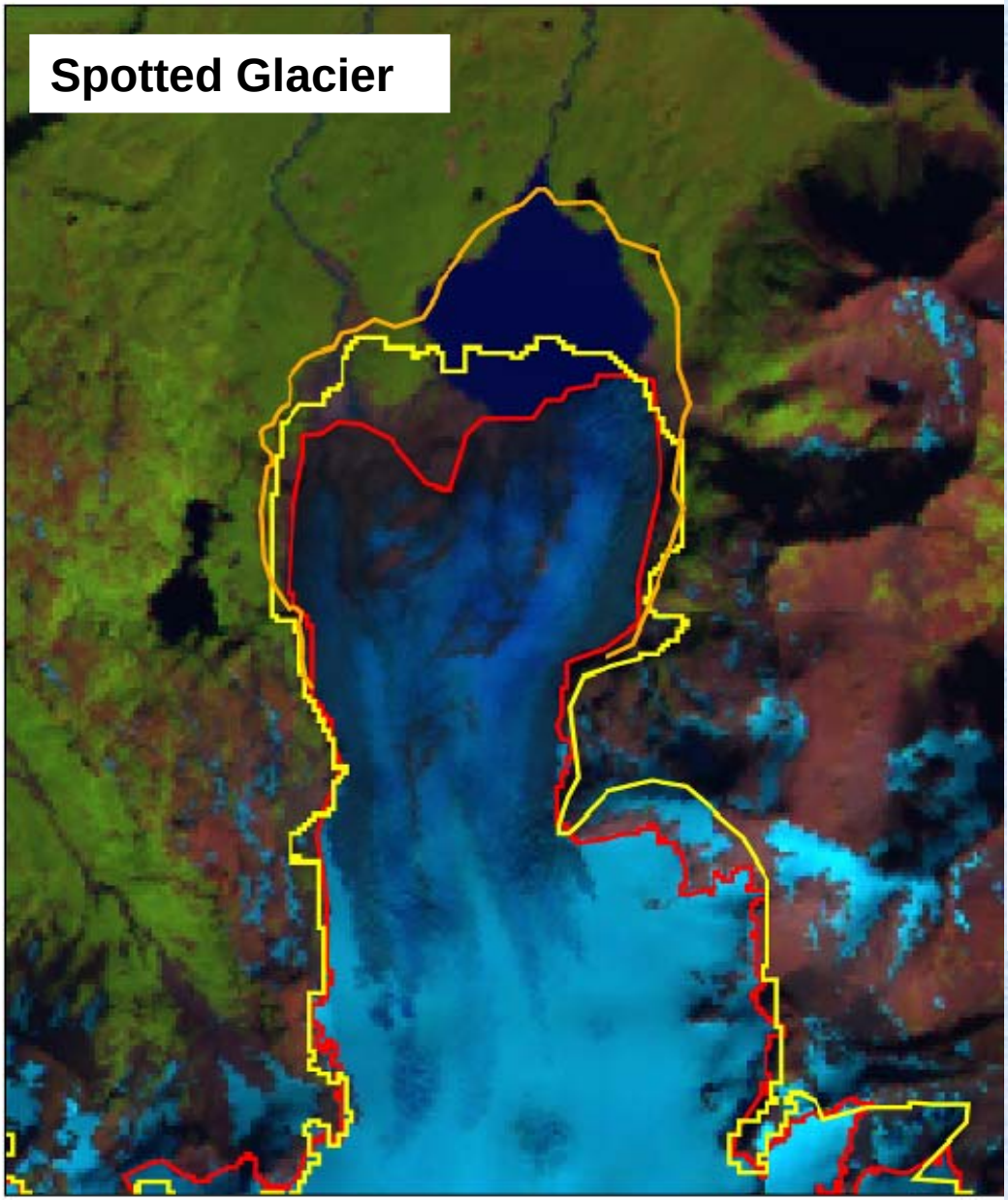
Cape Douglas Area



1951

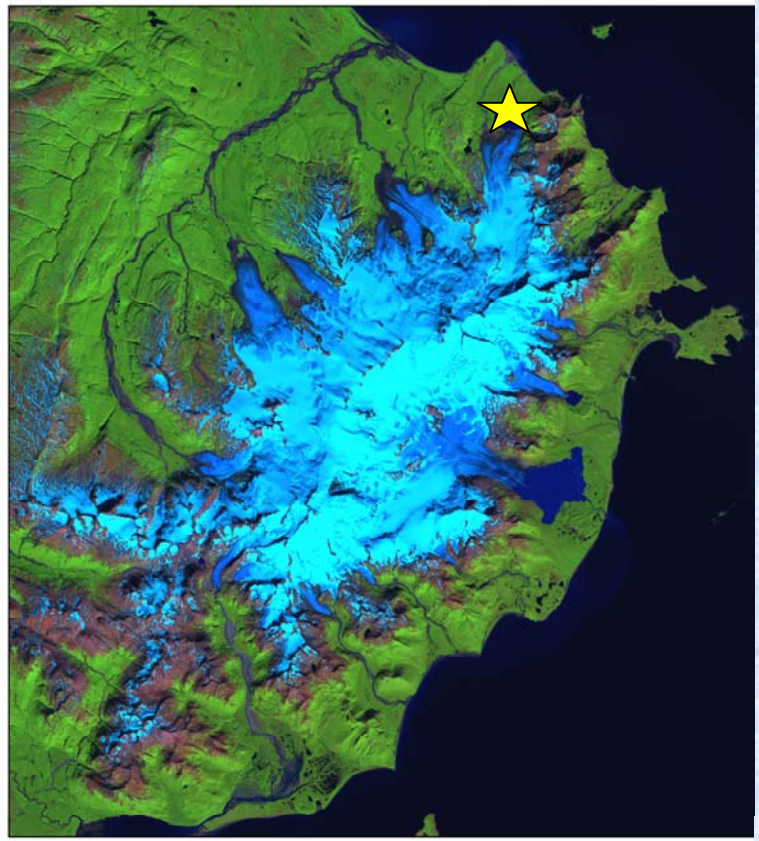
1974

Spotted Glacier



Landsat August 21, 1987

Cape Douglas Area

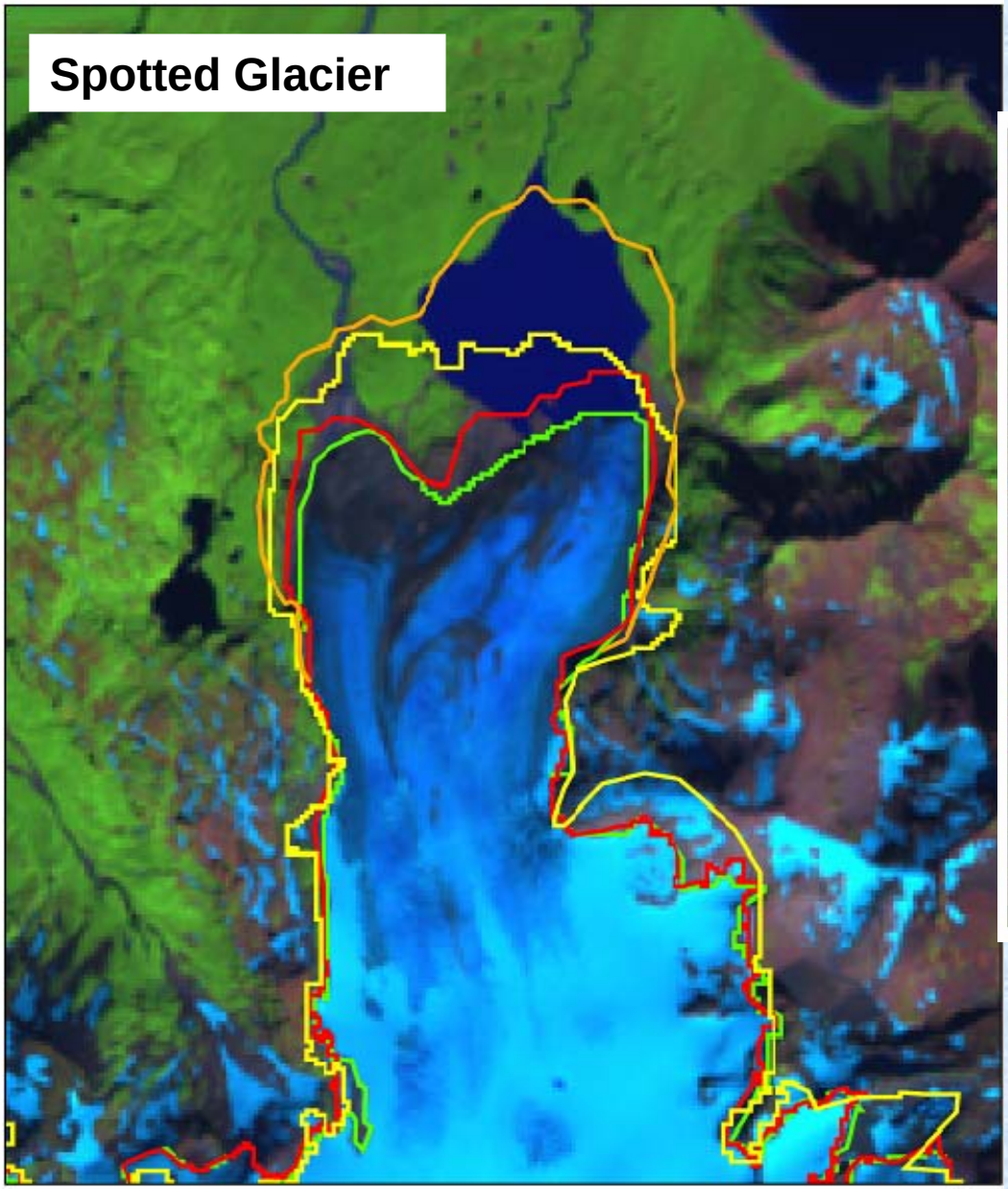


1951

1974

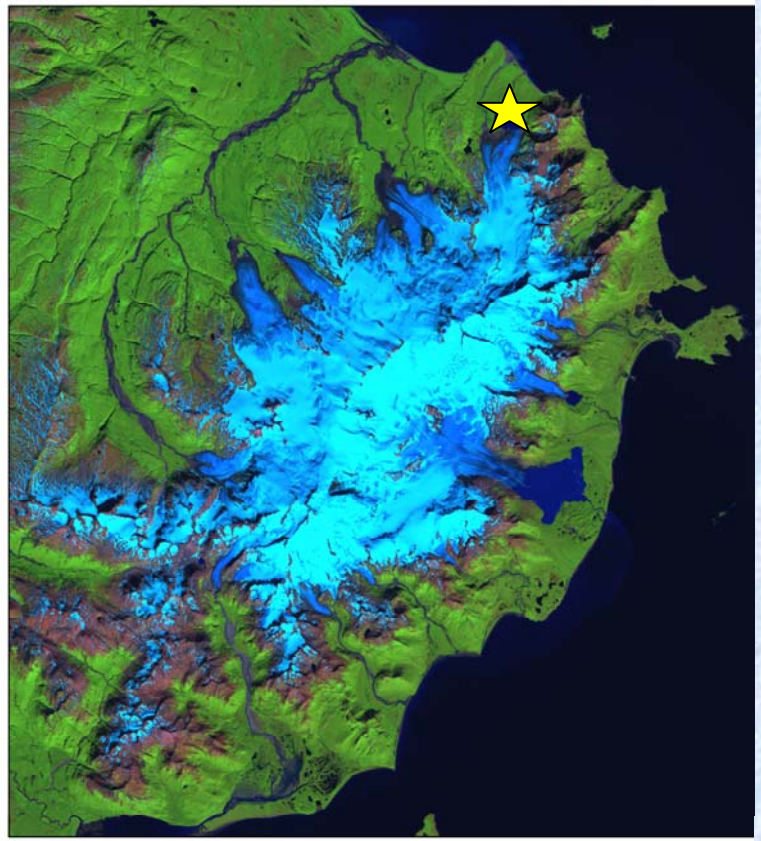
1987

Spotted Glacier



Landsat August 16, 2000

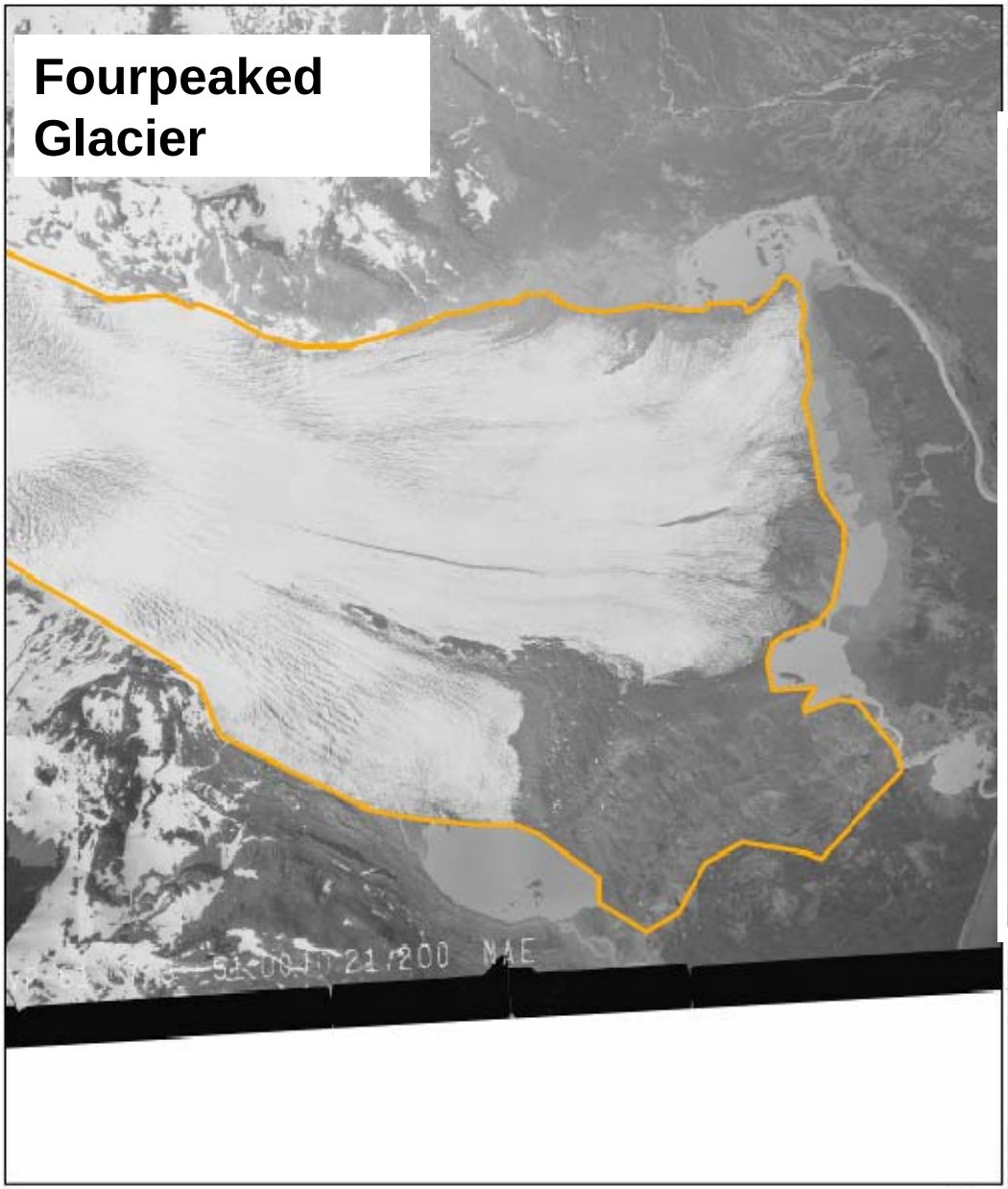
Cape Douglas Area



~1452±136 m recession
from 1951-2000

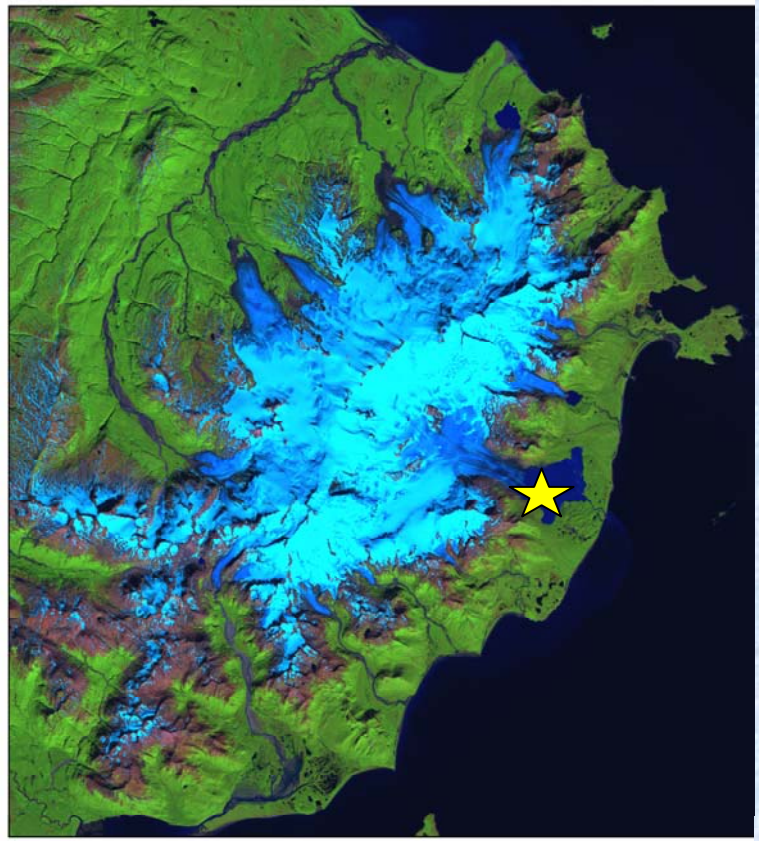
1951
1974
1987
2000


Fourpeaked
Glacier
21 10:11 AM



USGS Aerial Photo
July, 1951

Cape Douglas Area



1951

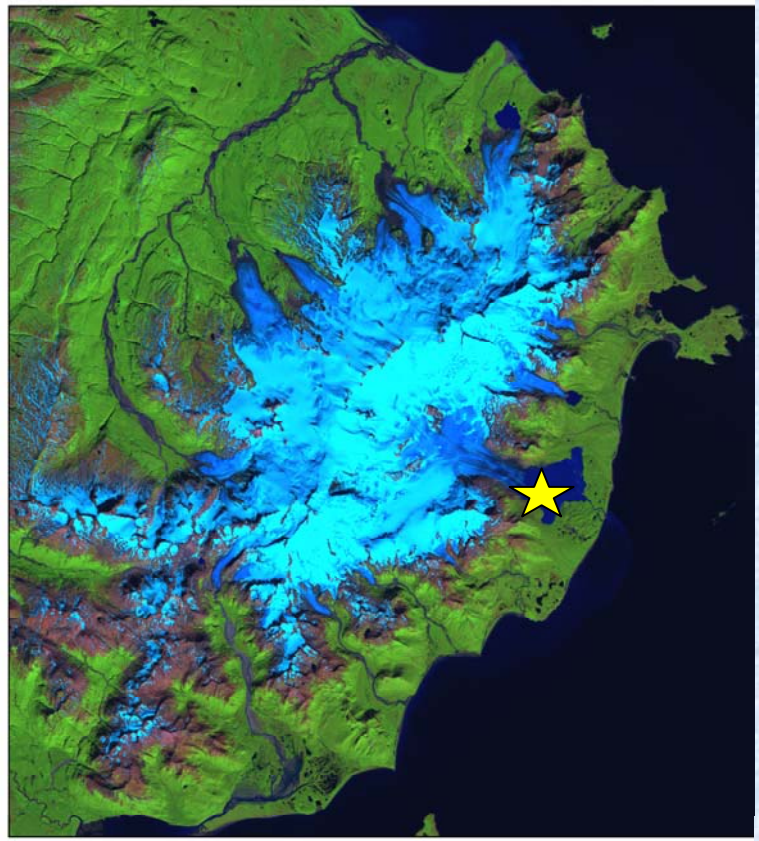
Fourpeaked Glacier

Landsat July 27, 1974

0 0.5 1 1.5 2
Kilometers

N

Cape Douglas Area



1951

1974

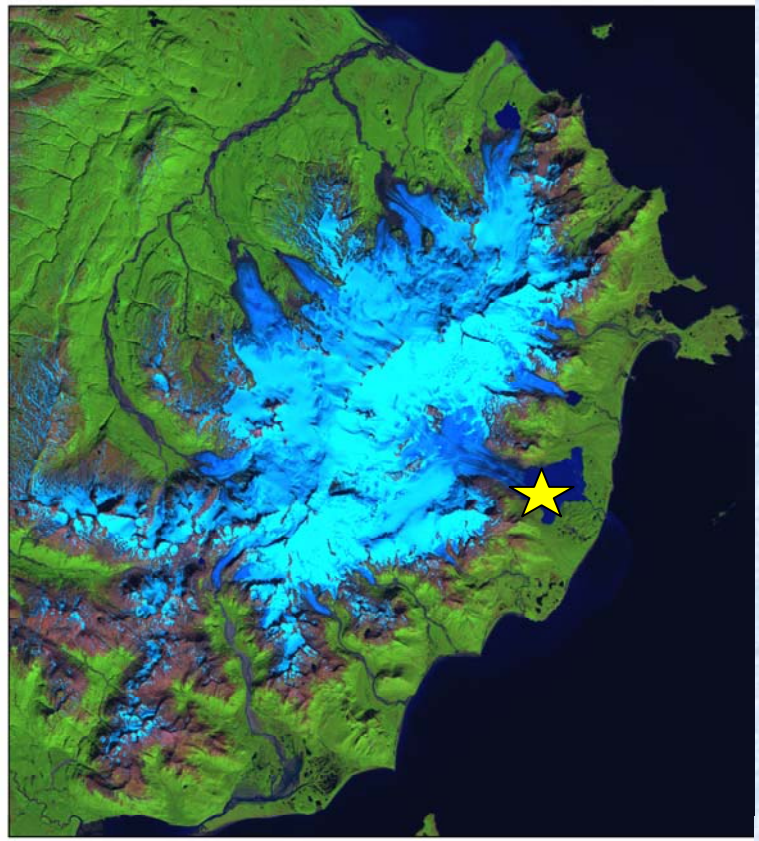
Fourpeaked Glacier

Landsat August 21, 1987

0 0.5 1 1.5 2
Kilometers

N

Cape Douglas Area



1951

1974

1987

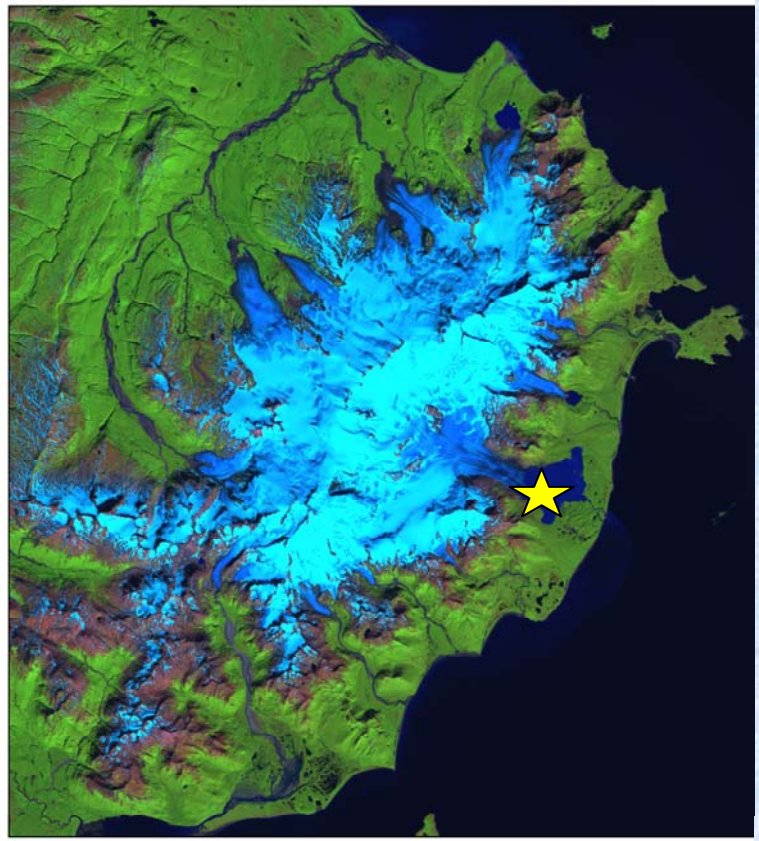
Fourpeaked Glacier

Landsat August 16, 2000

0 0.5 1 1.5 2
Kilometers

N

Cape Douglas Area



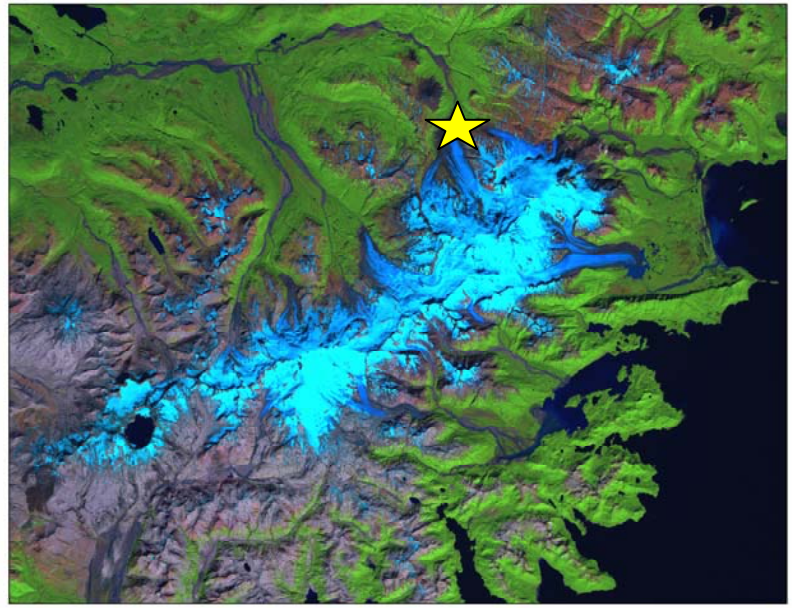
~3600±136 m recession from 1951-2000

1951
1974
1987
2000


Hook Glacier
20 1:16 PM

Hook Glacier

Mt. Katmai Area



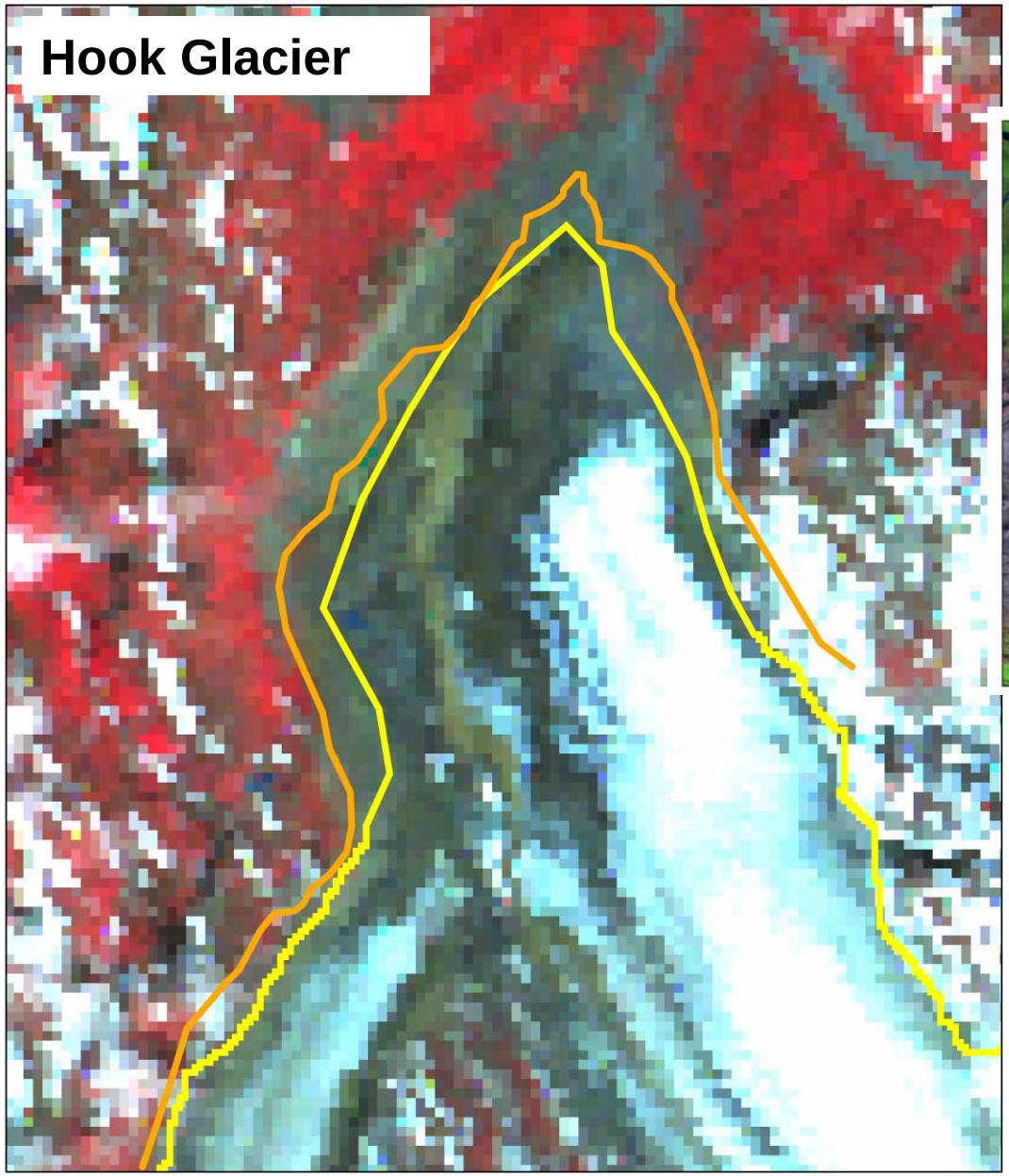
1951

USGS Aerial Photo
July, 1951

N

0 0.5 1 1.5 2
Kilometers

Hook Glacier

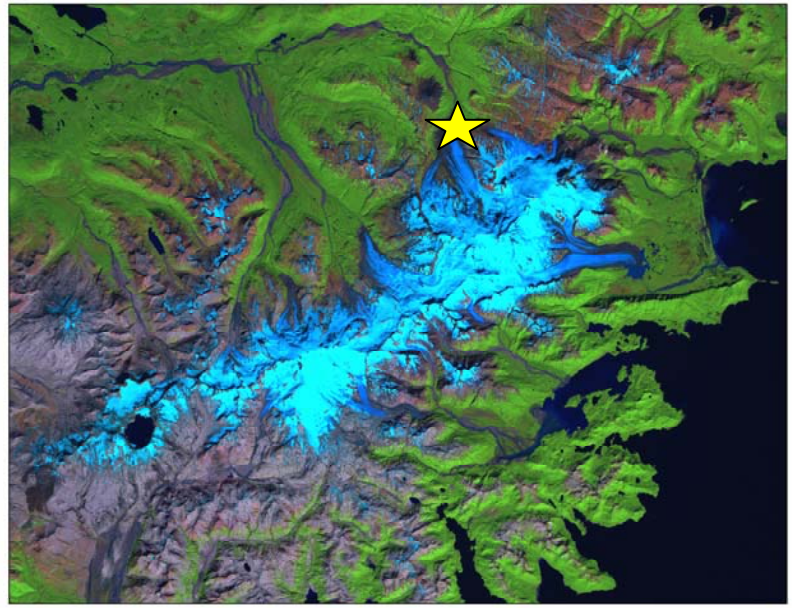


N

0 0.5 1 1.5 2
Kilometers

Landsat July 27, 1974

Mt. Katmai Area

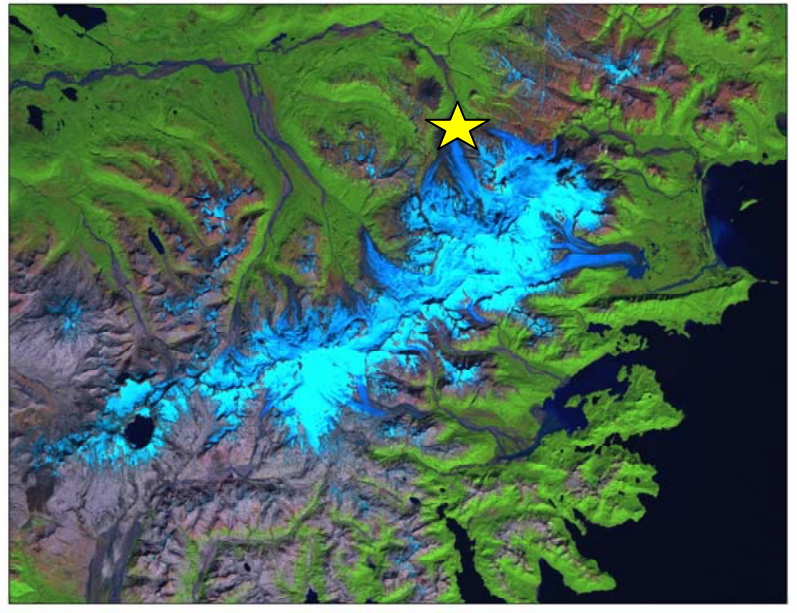


1951

1974

Hook Glacier

Mt. Katmai Area



1951

1974

1987

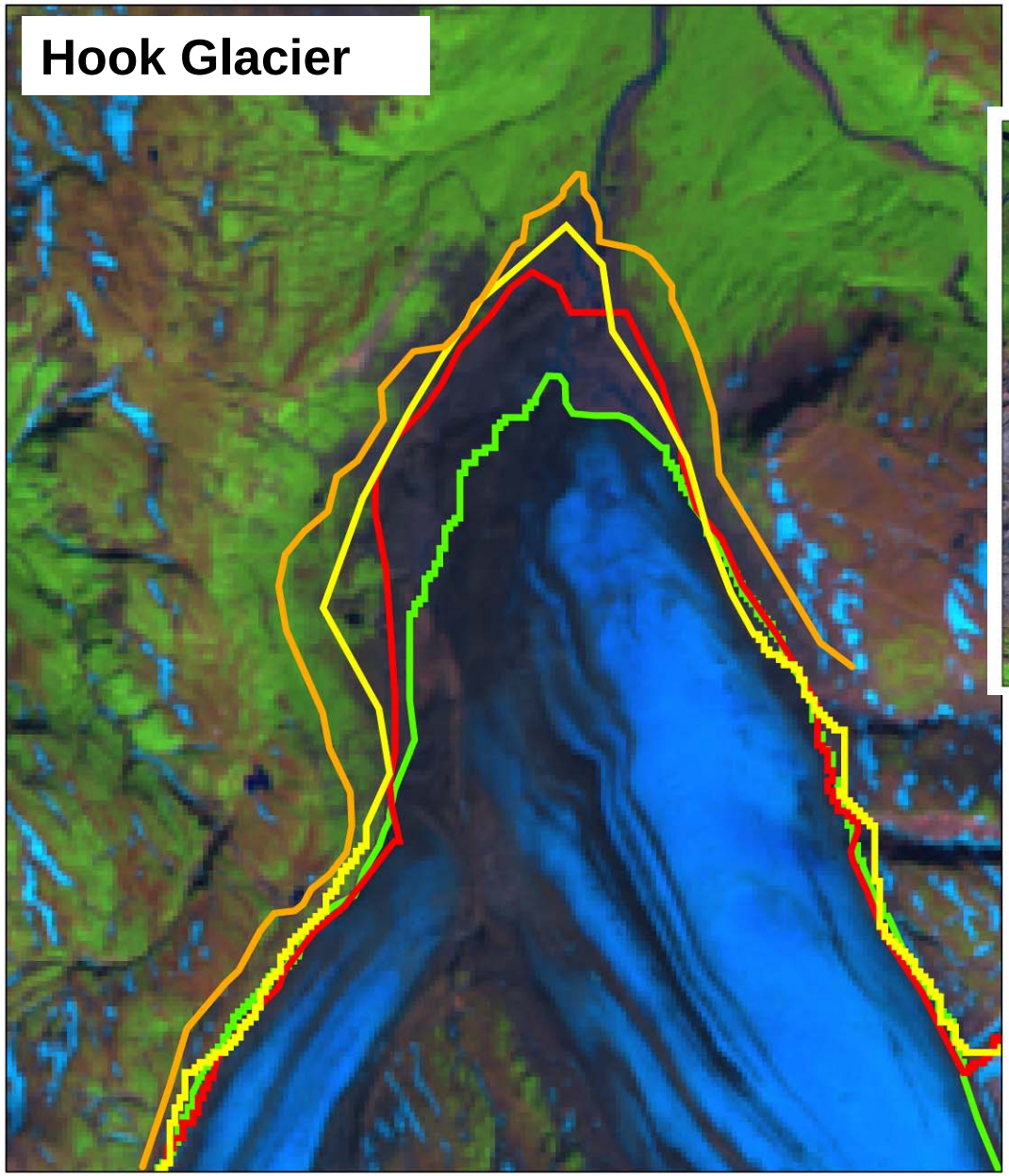
N

0 0.5 1 1.5 2

Kilometers

Landsat August 21, 1987

Hook Glacier

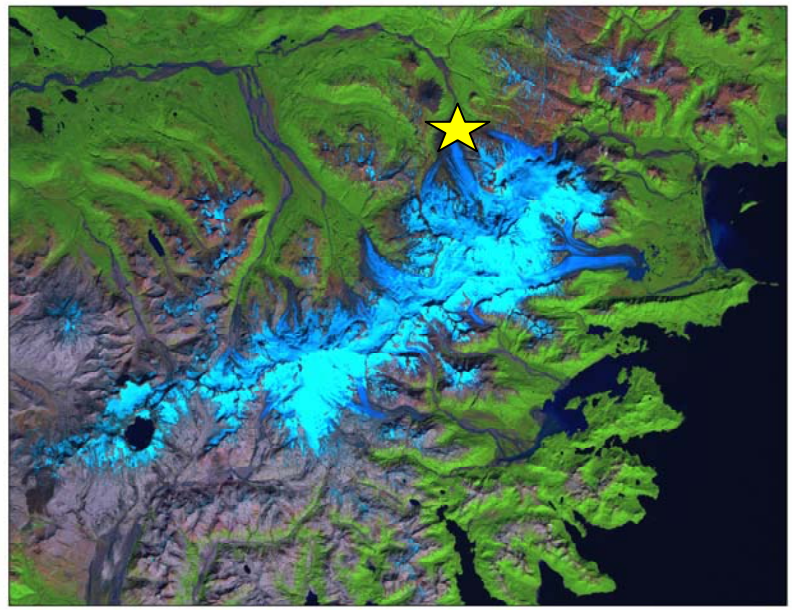


N

0 0.5 1 1.5 2
Kilometers

Landsat August 16, 2000

Mt. Katmai Area

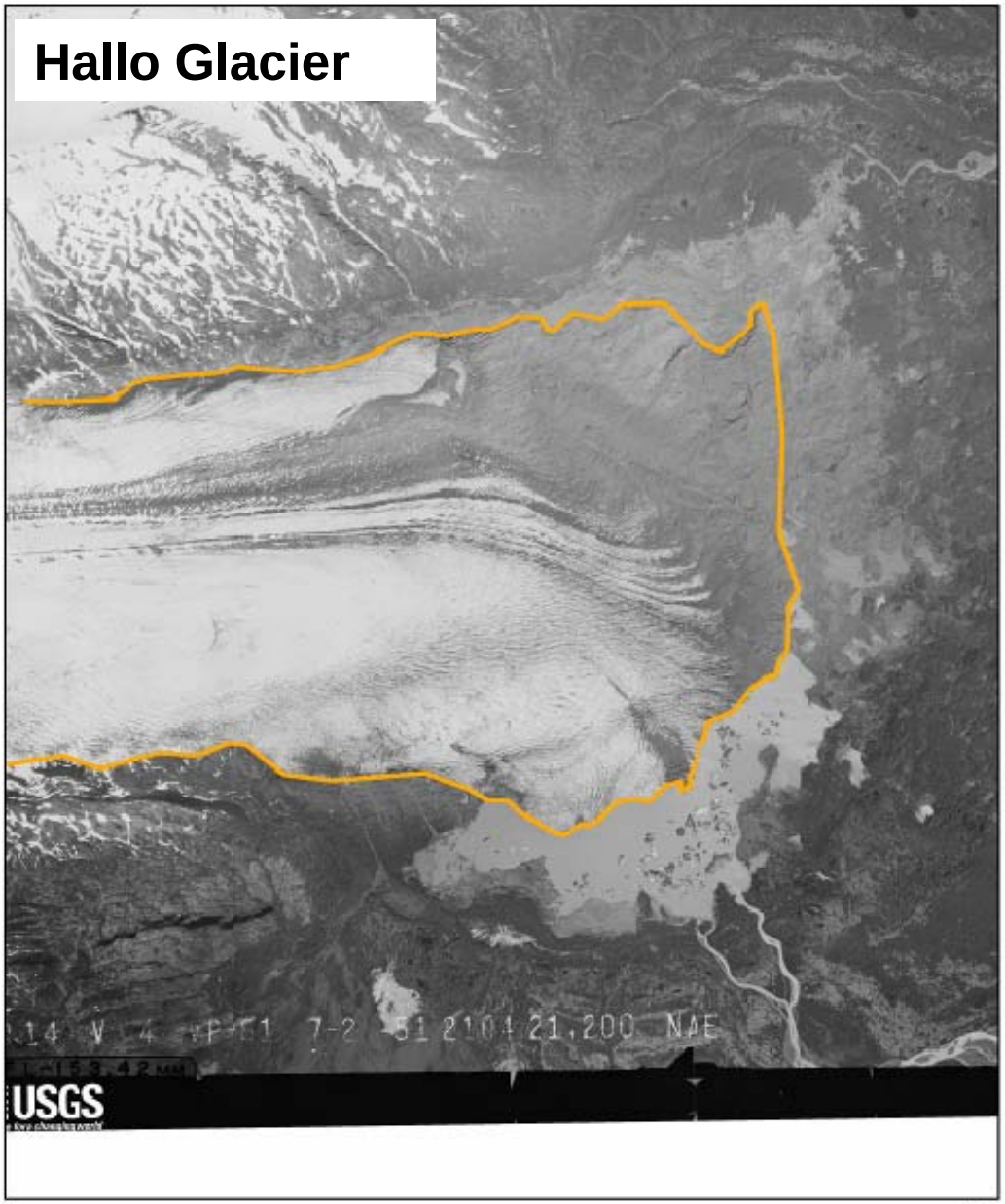


~1203±136 m recession
from 1951-2000

1951
1974
1987
2000


Hallo Glacier
21 10:47 AM

Hallo Glacier

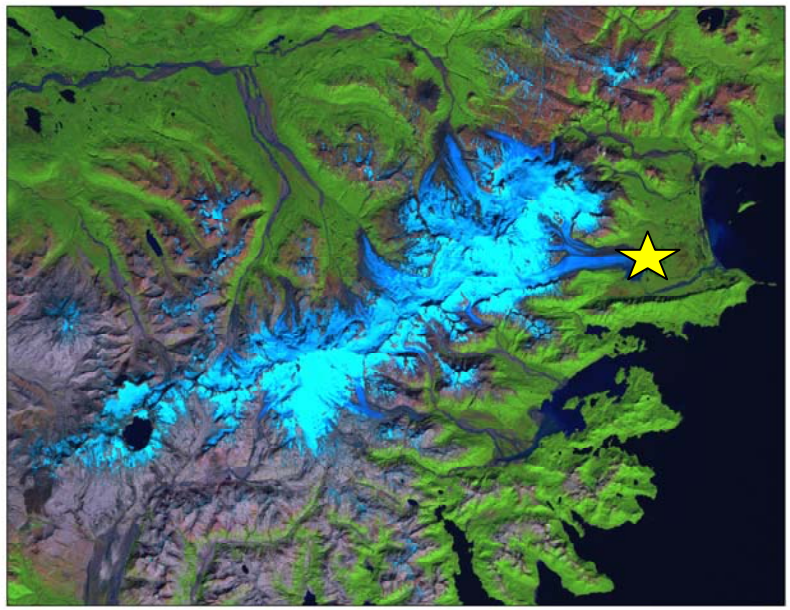


USGS Aerial Photo
July, 1951

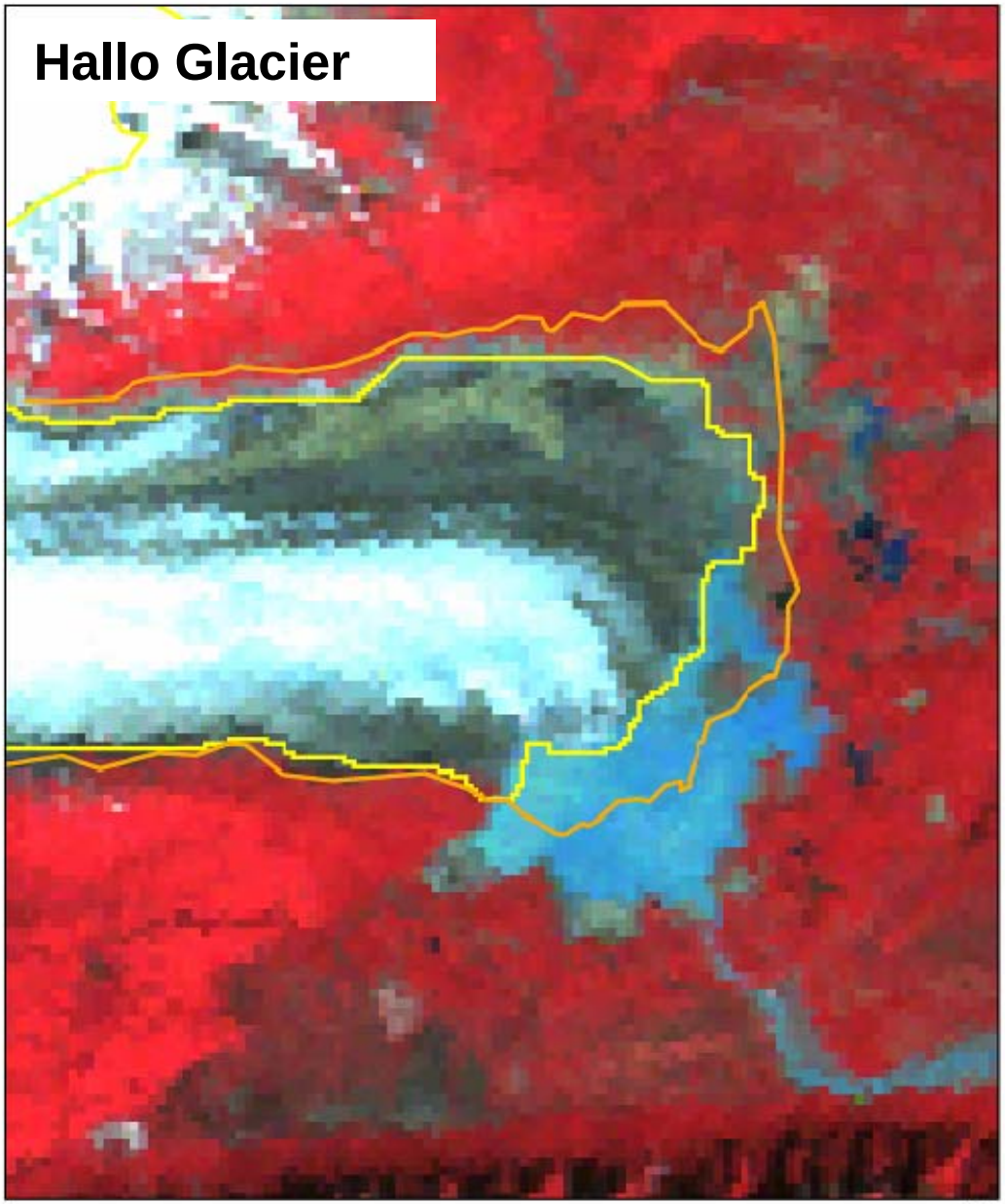
0 0.5 1 1.5 2
Kilometers

N

Mt. Katmai Area

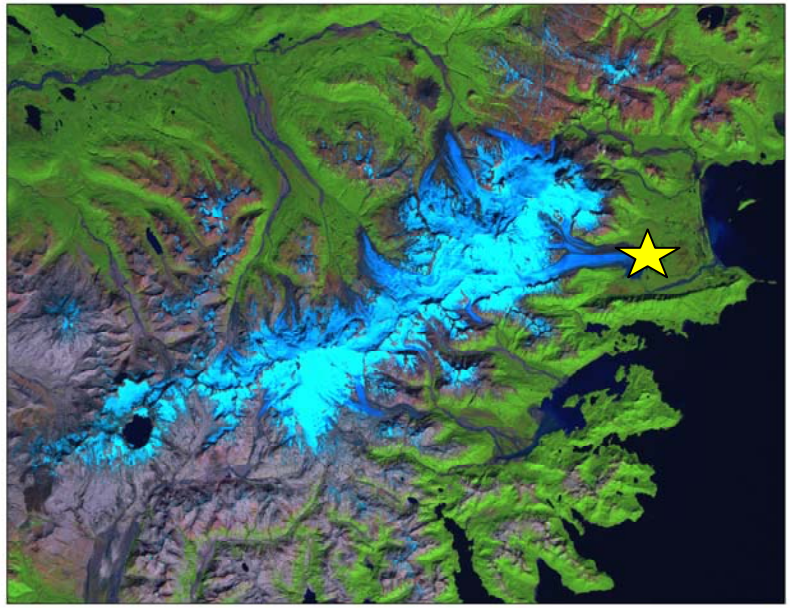


1951



Landsat July 27, 1974

Mt. Katmai Area



1951

1974

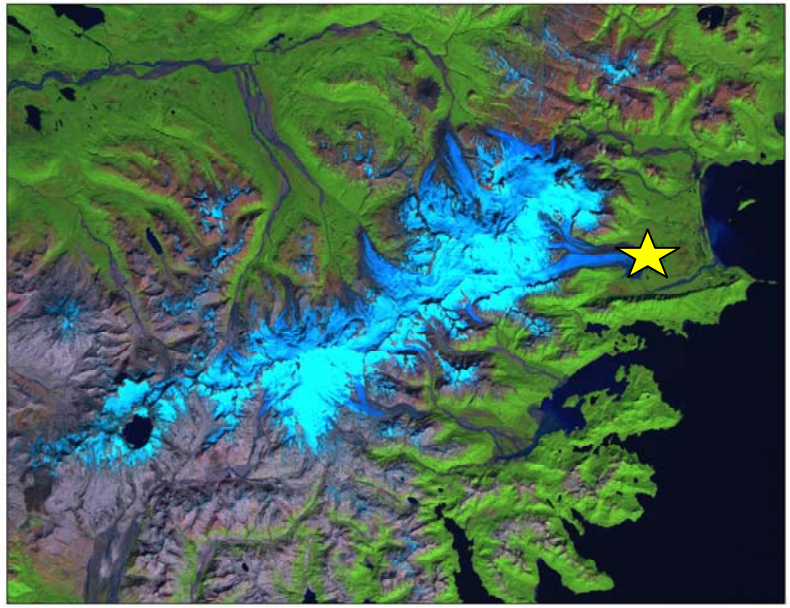
Hallo Glacier

0 0.5 1 1.5 2
Kilometers

N

Landsat August 21, 1987

Mt. Katmai Area

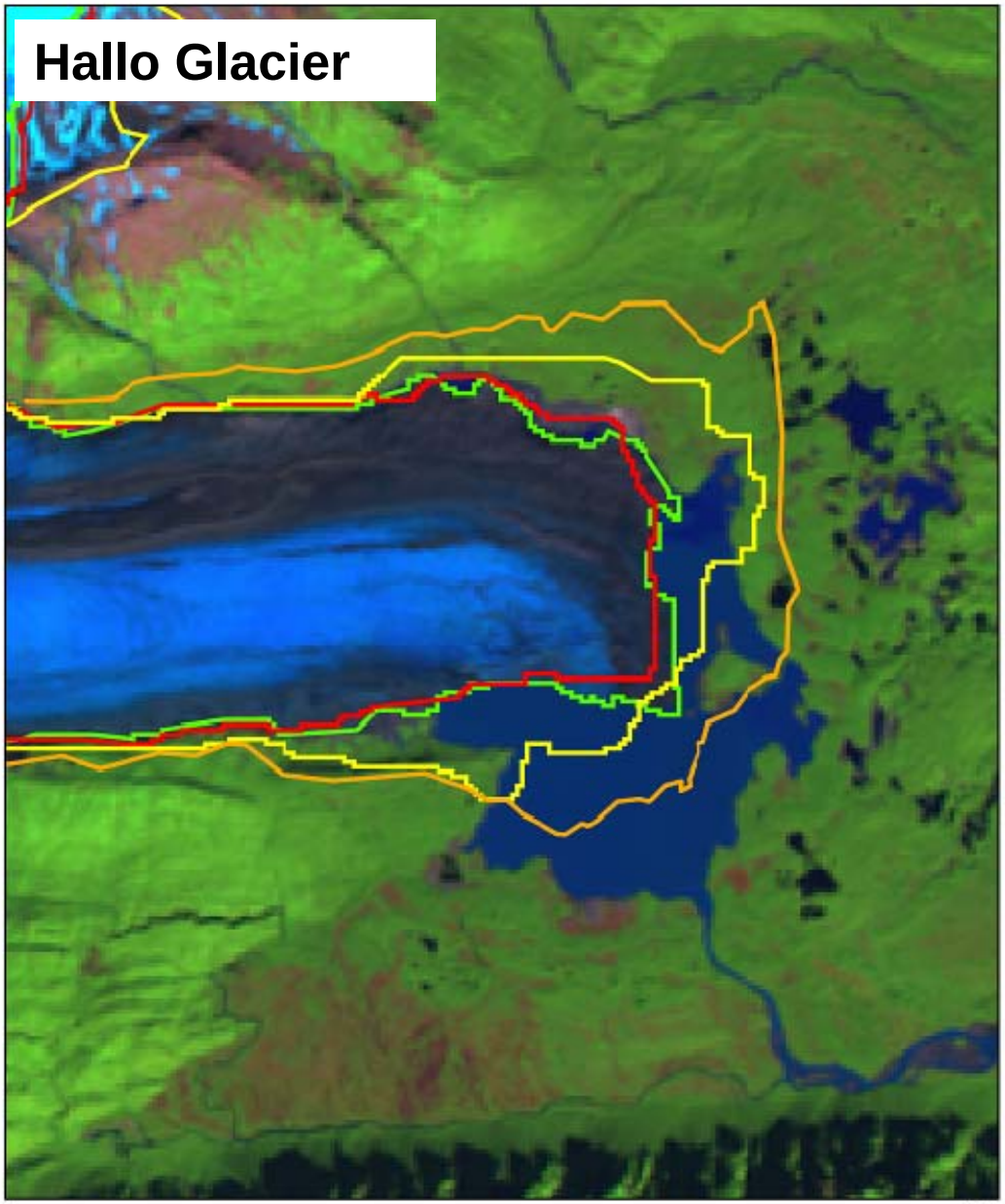


1951

1974

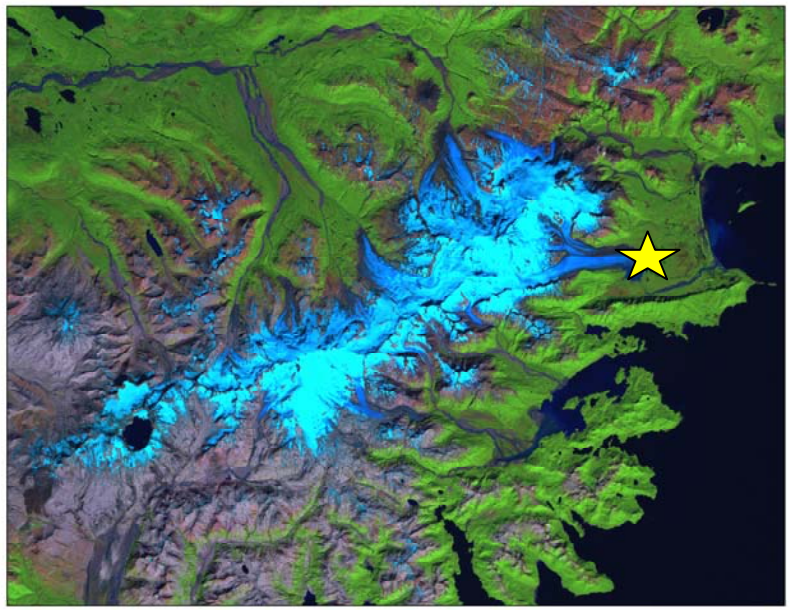
1987

Hallo Glacier



Landsat August 16, 2000

Mt. Katmai Area

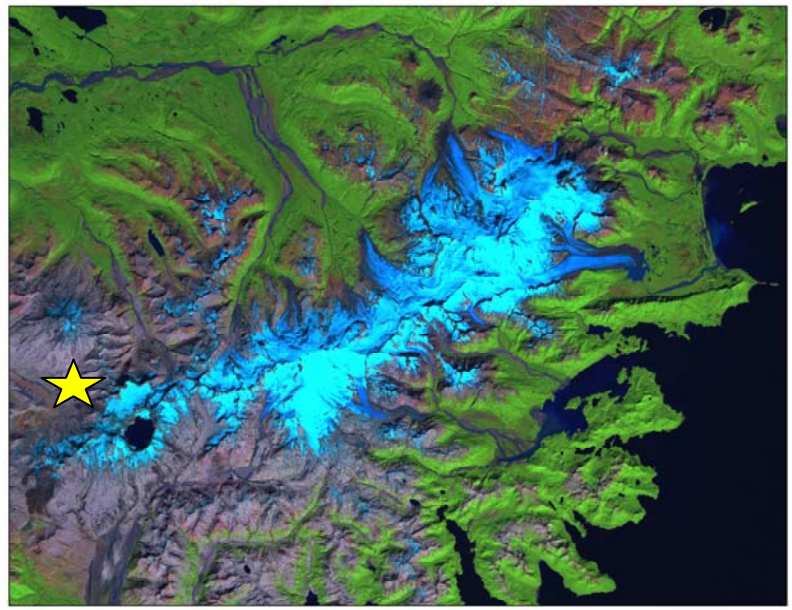


~765±136 m recession
from 1951-2000

1951
1974
1987
2000

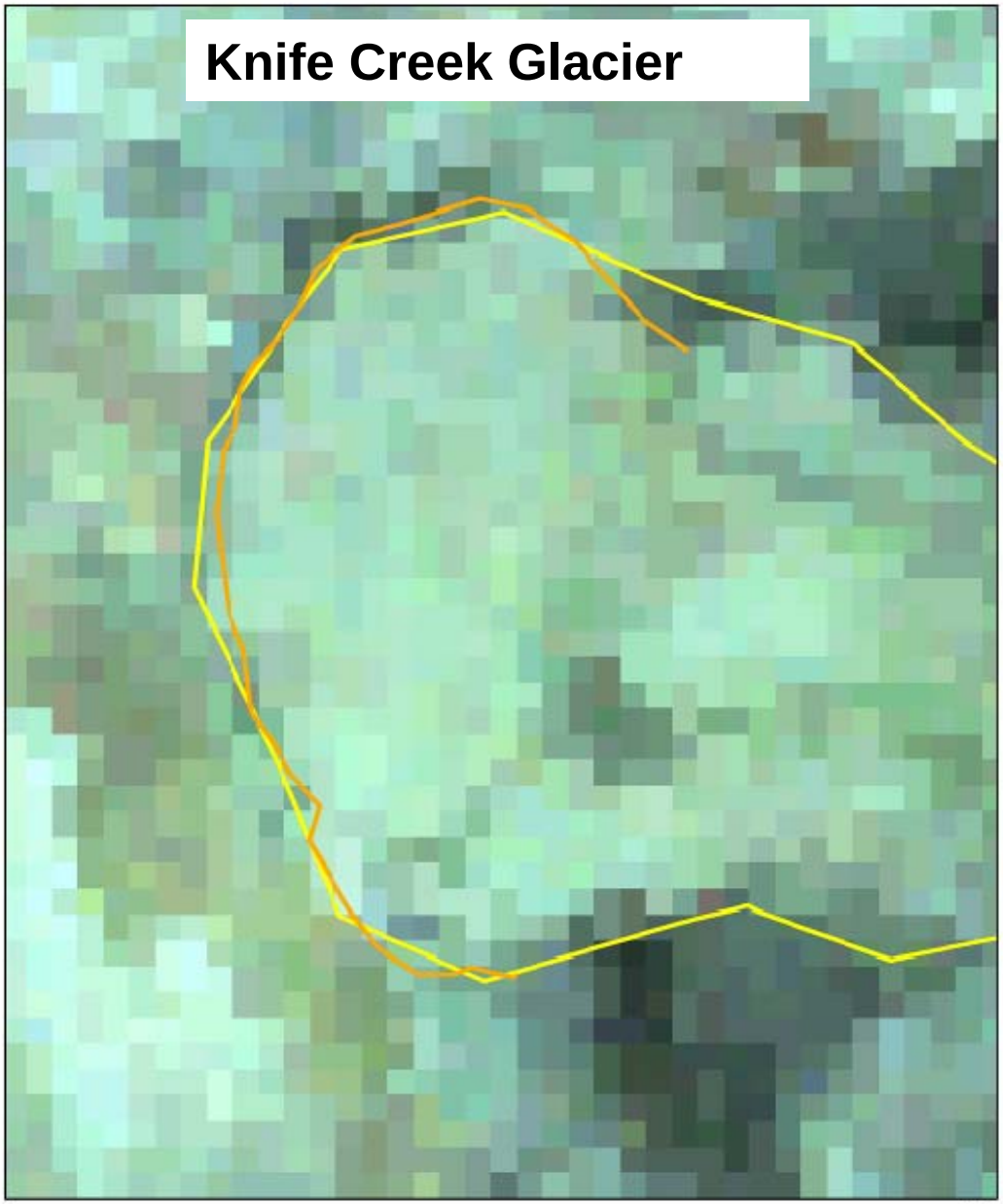
USGS Aerial Photo
July, 1951

Mt. Katmai Area



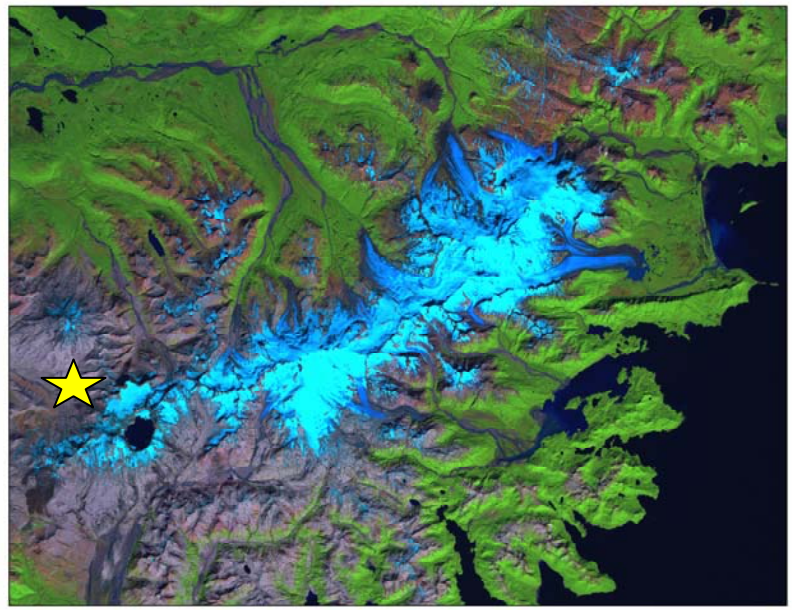
1951

Knife Creek Glacier



Landsat July 27, 1974

Mt. Katmai Area



1951

1974

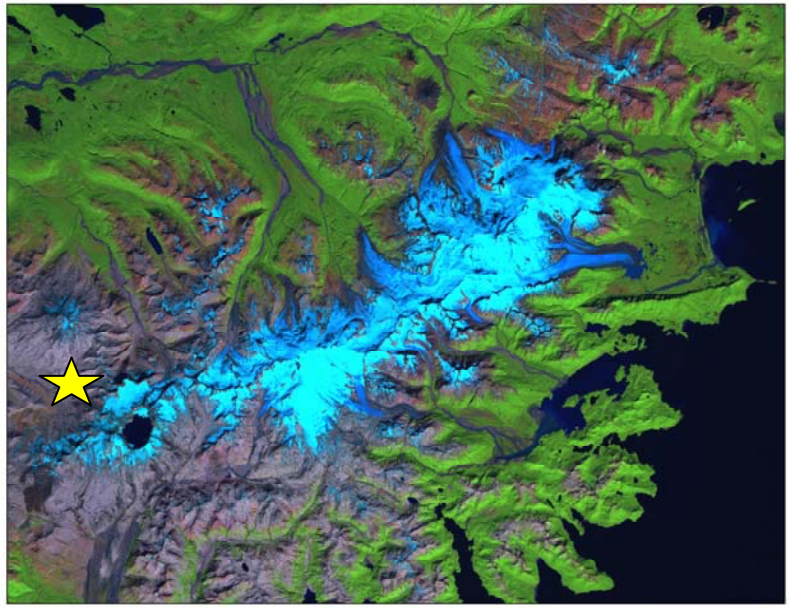
Knife Creek Glacier

0 0.25 0.5 0.75 1
Kilometers

N

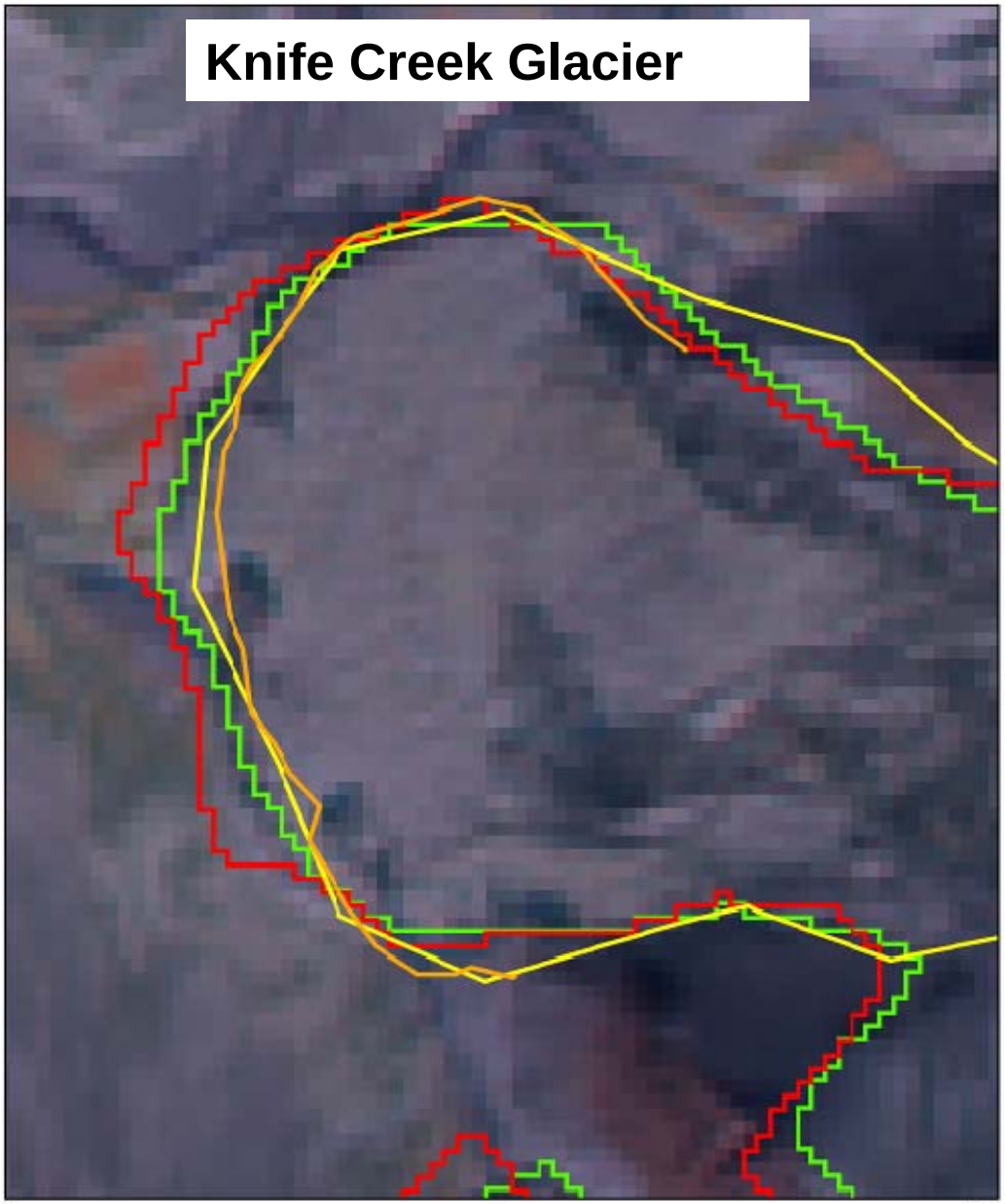
Landsat August 21, 1987

Mt. Katmai Area



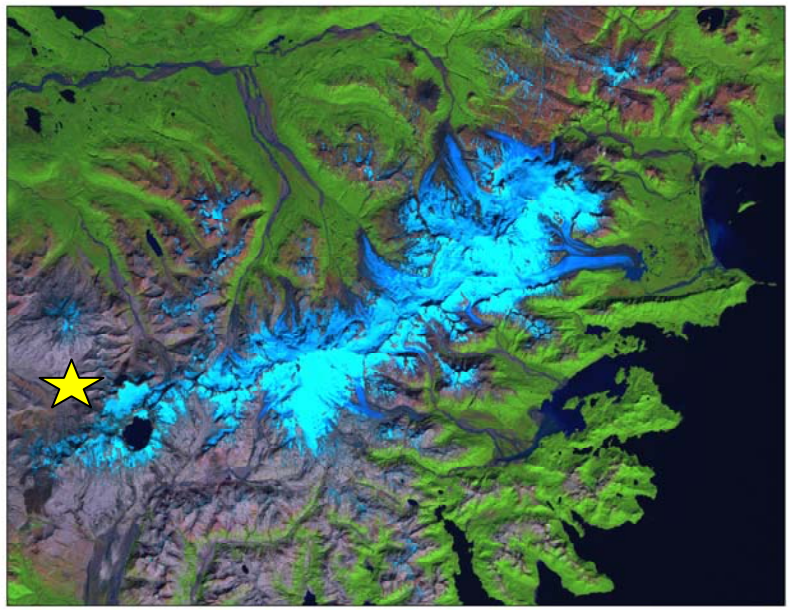
1951
1974
1987

Knife Creek Glacier



Landsat August 16, 2000

Mt. Katmai Area



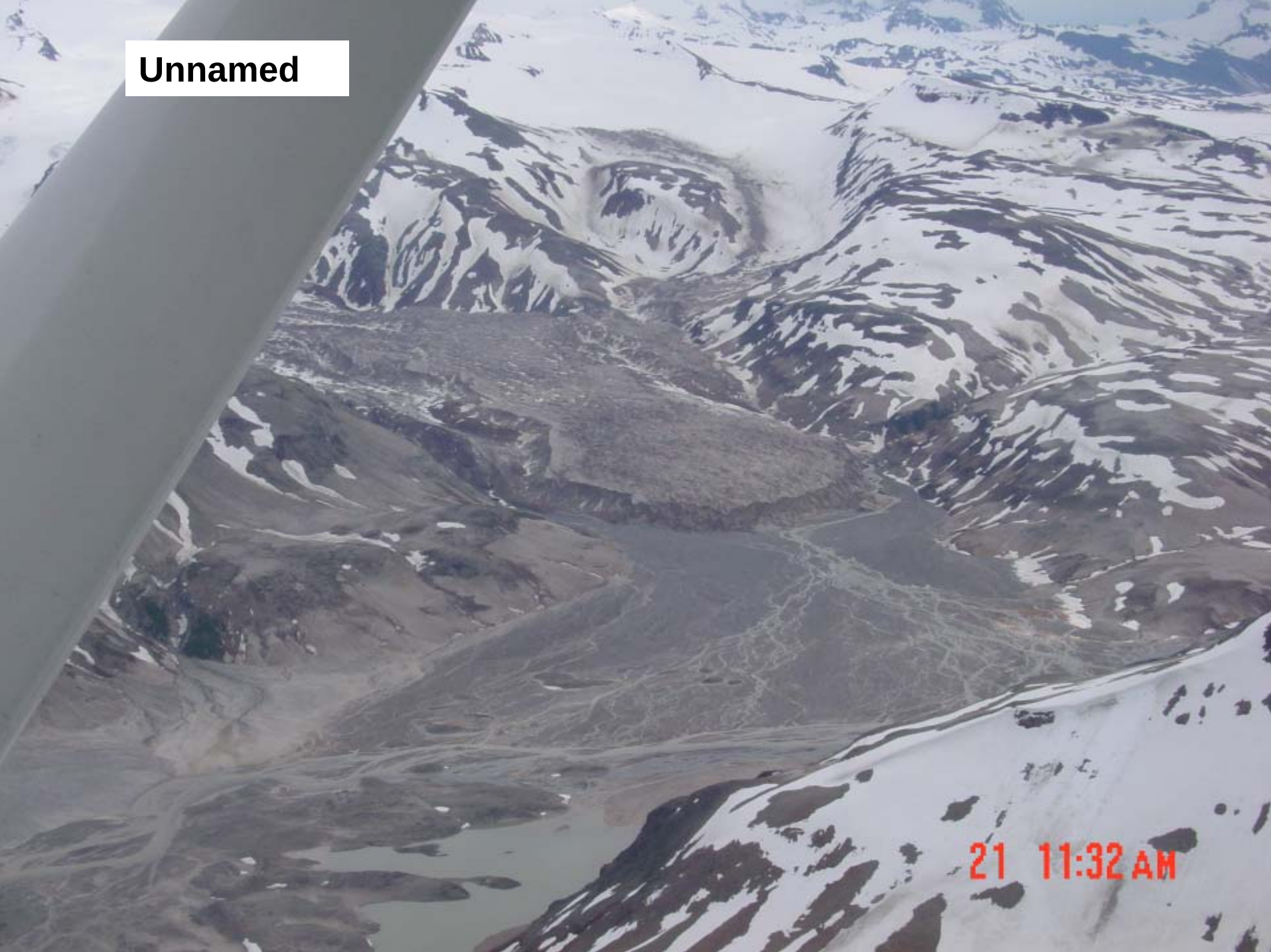
~36±136 m advance from 1951-2000

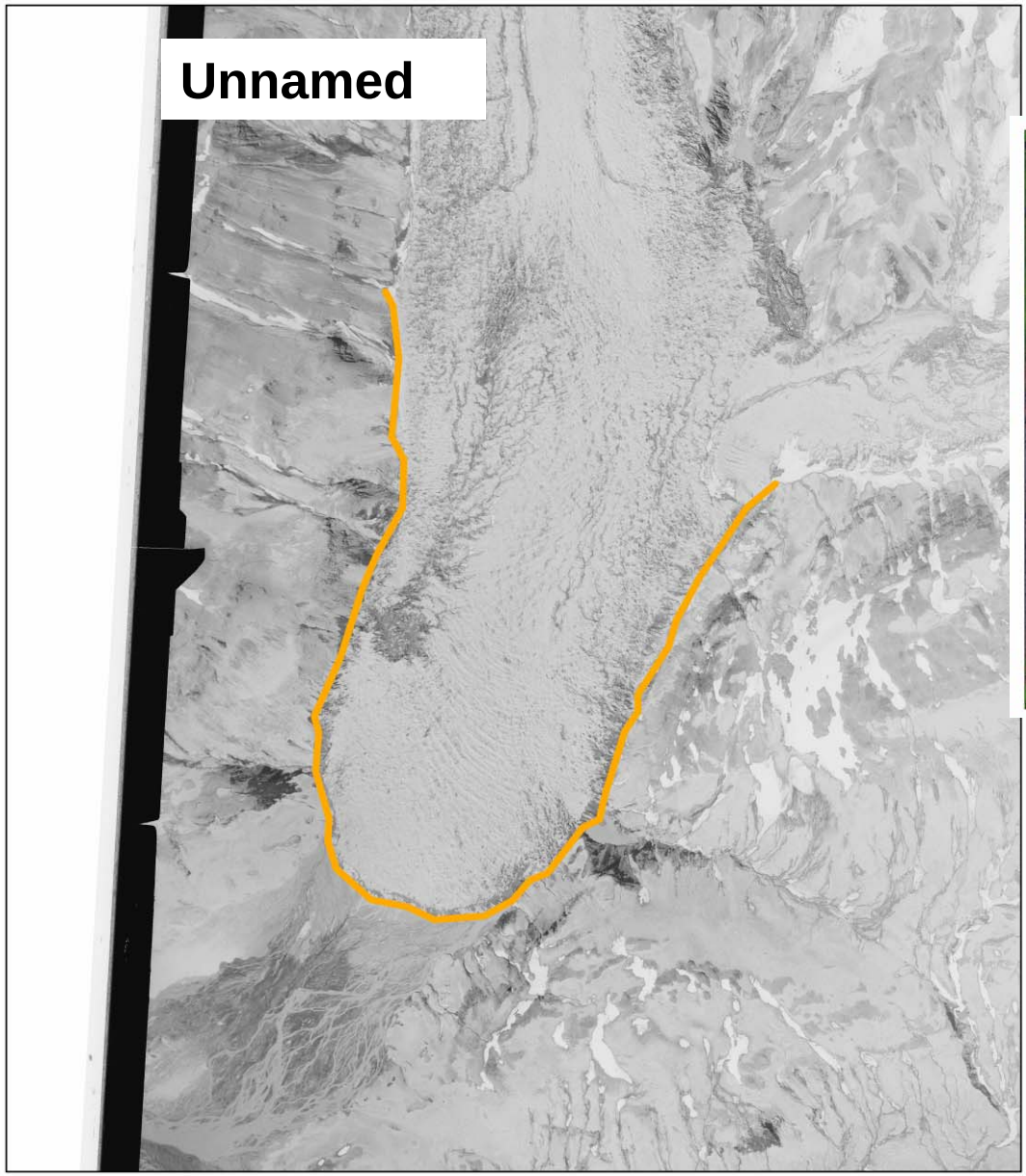
1951

1974

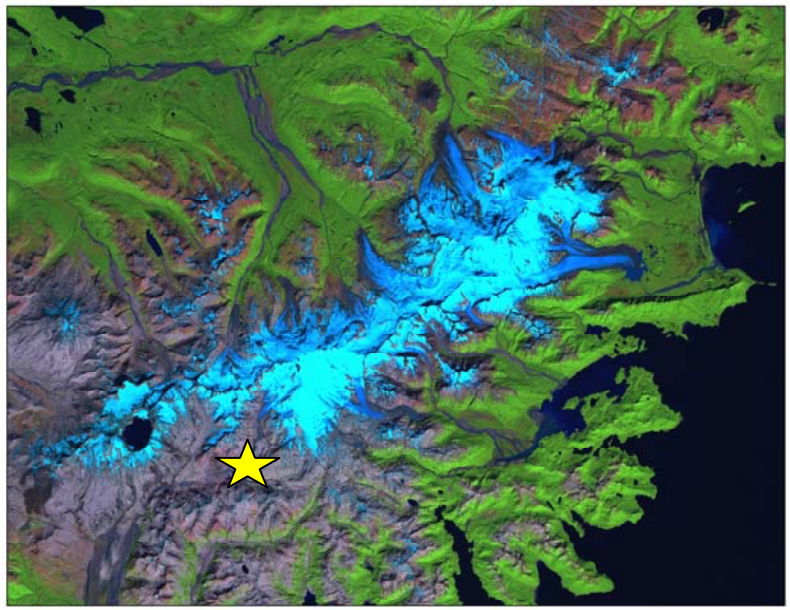
1987

2000


Unnamed
21 11:32 AM



Mt. Katmai Area



1951

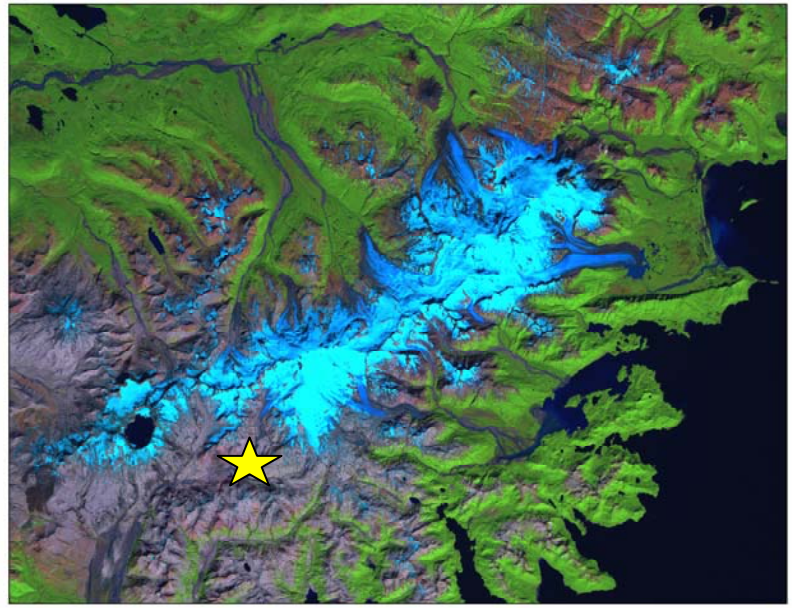
USGS Aerial Photo
July, 1951

0 0.5 1 1.5 2
Kilometers

N

Unnamed

Mt. Katmai Area



1951

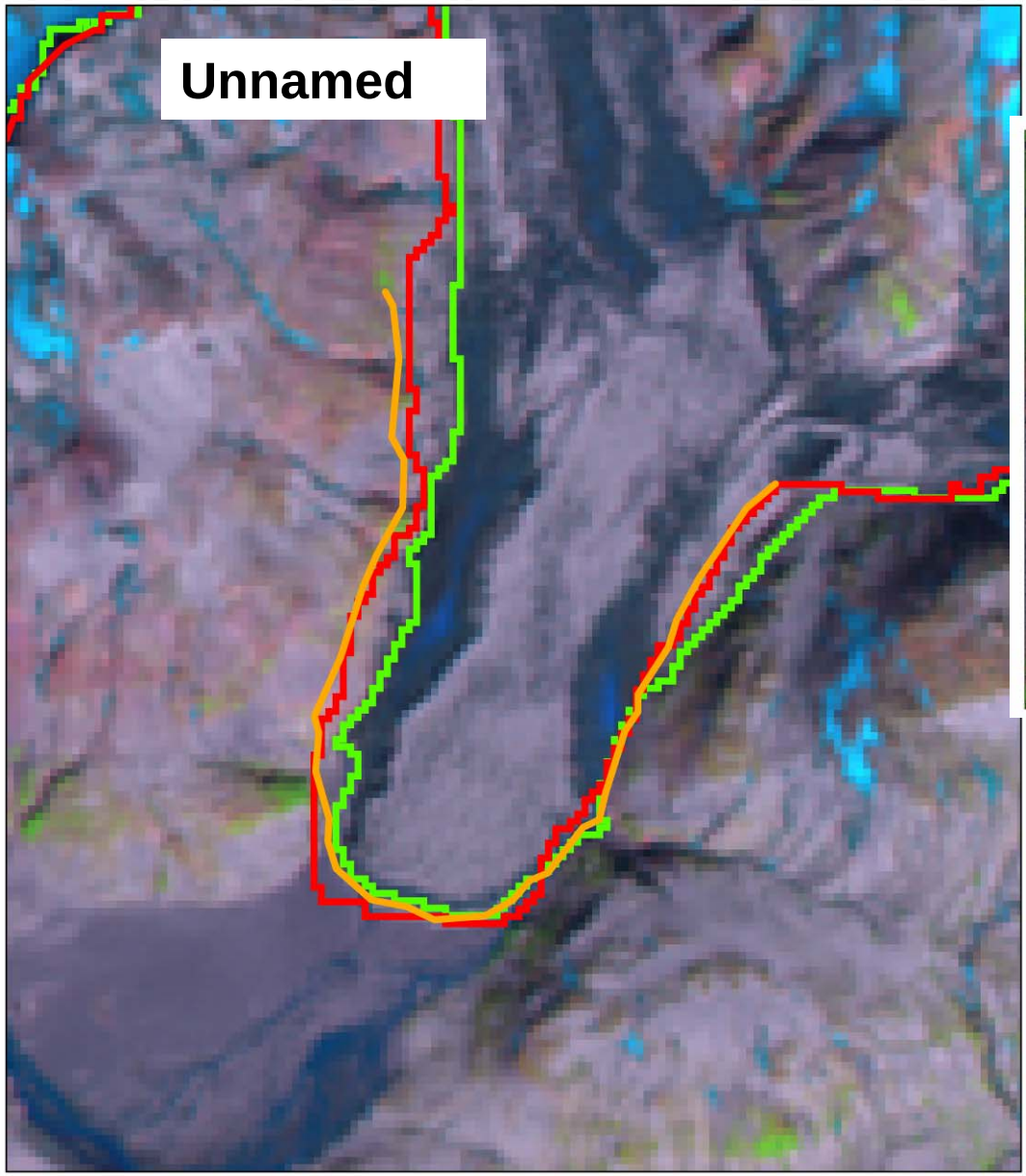
1987

0 0.5 1 1.5 2

Kilometers

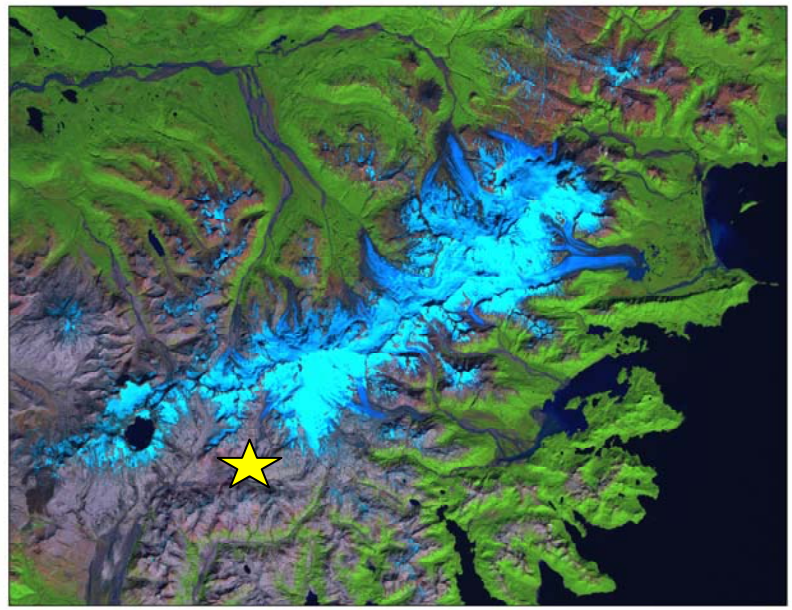
N

Landsat August 21, 1987



Landsat August 16, 2000

Mt. Katmai Area



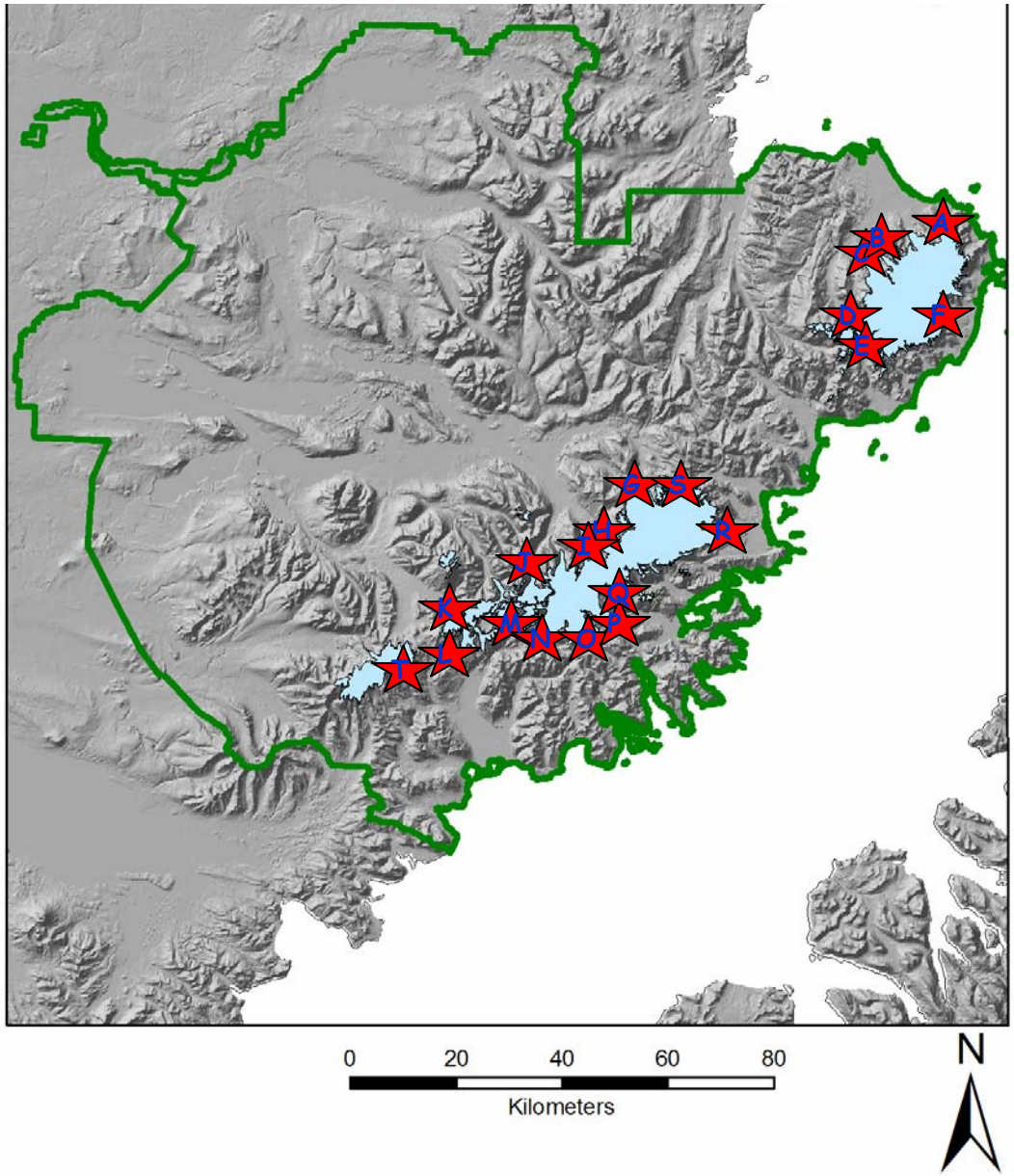
~27±136 m recession
from 1951-2000

1951

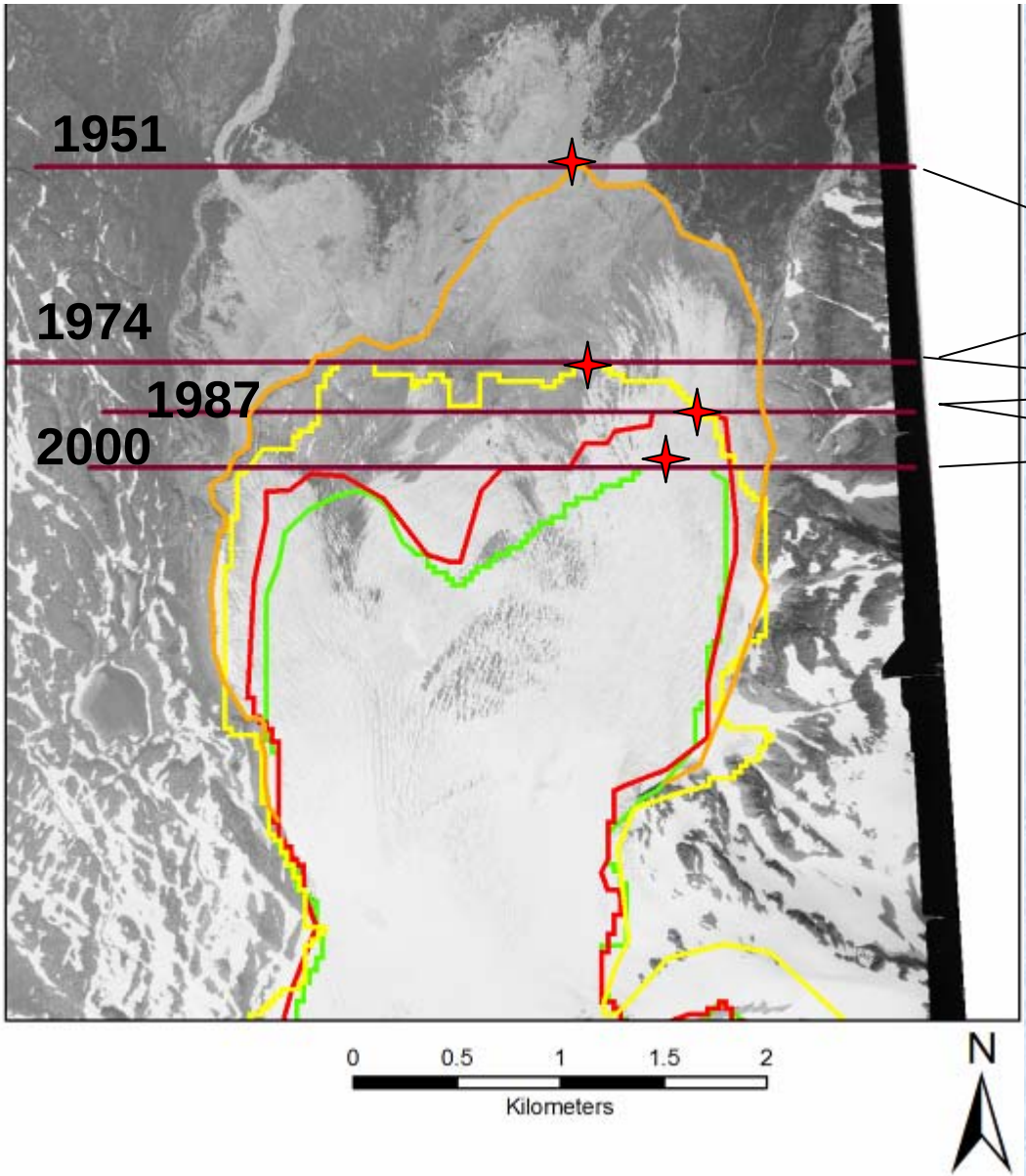
1987

2000

Rate of Change of the Terminus Position of Selected Glaciers in KATM



Measuring Glacier Terminus Change



-944 m (1951 to 1974)

-242 m (1974 to 1987)

-266 m (1987 to 2000)

-1452 m (1951 to 2000)

Measurements based on furthest down-valley extent of the glacier

Average Rate of Terminus Change (meters per year)

		1951 To 1974		1974 To 1987		1987 To 2000
Coastal and Interior Glaciers		-17.3		-33.8		-13.4
Interior Glaciers - North and West Flowing		-18.3		-20.2		-17.6
Coastal Glaciers - South and East Flowing		-16.2		-49.3		-9.1

Summary and Conclusions

- Glacier terminus position determined by Landsat data is only one indicator of mass balance
- Results show net recession of glaciers in the three glaciated areas of KATM since 1974
- Interestingly, the glacier recession seems to have slowed somewhat between the two study periods: 1974 to 1987 being more rapid than 1987 to 2000 (based on terminus position measurements)

Summary and Conclusions

- Reduced rates of recession maybe explained because the glacier termini have receded towards the thicker ice of the source areas

- Interior glaciers seem to show slightly higher rates of recession than coastal glaciers (1987-2000 period)

- Landsat cannot tell us anything about the thickness of the ice

- Because of the lack of previous glacier studies in KATM, no comparison analysis can be made.

Future Plans

- Begin glacier extent mapping in Lake Clark National Park and Preserve
- Provide glacier extent shape files to the GLIMS program (Global Land Ice Measurements from Space)
- My dream data: a high quality digital elevation model

End